INDIAN FOREST INSECTS

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Inner surface of bark of green deodar (*Cedrus deodara*) showing the central egg-tunnels and offshoot larval galleries of *Scolytus major*, Steb. Living larvae are shown at the end of their galleries and some living female beetles on the bark. The bright colouring of the inner bark is due to its having been just stripped off a living tree. Chamba, North-West Himalaya, June 1909. Drawn and painted by M. E. Stebbing.

INDIAN FOREST INSECTS

OF ECONOMIC IMPORTANCE

COLEOPTERA

BY

EDWARD PERCY STEBBING

of the Indian Forest Service. Head of the Department of Forestry, University of Edinburgh. Late, Imperial Forest Zoologist and Member of the Forest Research Institute, Dehra Dun, India. Member of the Permanent Committee of the International Entomological Congress. Fellow of the Linnean, Zoological, Royal Geographical, and Entomological Societies of London

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Inner surface of bark of green deodar (*Cedrus deodara*) showing the central egg-tunnels and offshoot larval galleries of *Scolytus major*, Steb. Living larvae are shown at the end of their galleries and [illegible] in the bark. The bright colouring of the inner bark is due to its having been just removed off a living tree. Chakrata, North-West Himalaya, June 1909. Drawn and painted by [illegible]

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PREFACE

THE chief aim of this book is the study of the Insect Fauna of the Indian forests from the economic standpoint. It is probably the first of its kind attempted for a British Dependency.

In 1898 the Government of India sanctioned the publication of a small compilation entitled *Injurious Insects of Indian Forests.* In this book I had gathered together the information then known on the subject of the life histories of insects of economic importance in the Indian forests.* The data included were mainly taken from *Indian Museum Notes*, issued from the Indian Museum, under the direction of Colonel A. Alcock, C.I.E., F.R.S., to whose advice during my early days in India I owe much. Since that year, chiefly through the interest and keenness displayed by officers of the Forest Department, both Imperial and Provincial, in advancing the study of this branch of forestry science, and to the generous aid extended towards the department by the Government of India, considerable progress has been made in a knowledge of a subject the importance of which in the preservation of the Forest Estate cannot be too strongly emphasized. In the absence of a thorough understanding of the life histories of important pests it is impossible to attempt to prescribe remedial or protective measures. Equally undesirable, in the absence of such knowledge, is it to take up an attitude of *non possumus* when considering the efficient application of measures of this kind over the large tracts with which the Indian forester has to deal. It is fully admitted that the study is only in the pioneer stage, and this book has no pretensions to be more than that of a pioneer endeavouring to indicate in some small degree the lines upon which the further study of the subject should proceed. So vast is the field opened out that almost of necessity it is likely to prove advisable to confine future publications to local provincial brochures in which the important pests of the trees of economic value in the forest areas concerned will be treated of. In dealing with the great mass of material available to

* In this work brief notes, many of them fragmentary, were given on some 130 insects. The important families Scolytidae and Platypodidae were represented by 4 and 0 species respectively. I am able to include here 74 and 20 species of these two families.

me it soon became evident that it could not be adequately compressed into a single volume if the request of the Government of India that the book should be kept within handy reference dimensions was to be complied with. I have therefore confined myself in this volume to the Coleoptera, by far the larger part, as it is the most important, of the subject.

The region dealt with is the same as that covered by the *Fauna of British India* volumes, viz., India and Burma, including Ceylon. It is considered probable, however, that the work will have a wider sphere than that of India and Burma, extensive as is the area of the great continent, and widely divergent as are its botanical and climatic characteristics. In Ceylon, the Malay States, and the farther East, many pests identical with or closely allied to those here dealt with, and having in all probability not dissimilar habits, are either already known to exist (as the distribution of many of those included in this work sufficiently illustrates) or are likely to be discovered. The book should therefore prove of value to planters and those interested in commercial concerns connected with the growth for profit of rubber, tea, coffee, and allied industries. The chapters devoted to the Cerambycidae, Curculionidae, Scolytidae, and Platypodidae, all containing serious pests, a knowledge of whose life histories may mean a saving of considerable sums of money, will make this evident.

The study of the insect fauna of the Indian and other Eastern forest tracts now coming under economic forest conservancy is of peculiar value to the zoologist interested in preserving, or endeavouring at least to make an acquaintance with, those more uncommon species of the fauna which are at present unknown, and which are likely to form important links in a working classification of some of the more difficult groups. Many of these links will inevitably disappear under the conversion of the tracts of primeval forest into areas managed on commercial lines. For the forester masses on the area a greater number of healthy stems per acre than Nature attempts to do; while endeavouring at the same time to ensure the prompt removal of all weakly, diseased, dying, and dead trees. Under such treatment it is easy to understand that large numbers of small forms of insect life now to be found perhaps in fair abundance in dying and dead stems throughout the primeval tracts of forest will disappear. Also, as is the case with the shyer mammals, so is it likely to prove with the shyer or rarer insects. The closing in and cutting up of the large tracts of forest in which they formerly roamed at will, combined with the heavy toll which the introduction of the modern rifle has exacted from their ranks, has resulted in the bison or gaur and the rhinoceros approaching perilously near to extinction in India. The former operation alone must, however, in time have brought about the same result. Similarly the changed conditions introduced with the progress of ordered forest conservancy are

likely to prove inimical--in a different manner, perhaps, but still inimical--to some of the rarer forms of insect life in the struggle for existence, and they will disappear. If this theory has any solid foundation on fact (and my own personal observations would seem to indicate that it has), from the point of view of the zoologist and the systematist it is of the first importance that the insect fauna of the Indian forests should be collected and classified. The spade-work that has already been accomplished affords sufficient evidence, if evidence be required, that this collection is equally necessary in the economic welfare of the Forest Estate.

That the value of this work is recognized is well illustrated by the illustrious band of European savants who are so freely and ungrudgingly giving their valuable time to naming and describing the Indian collections which are coming to hand.

In this volume I have dealt with Indian forest insects from two main aspects: firstly, the injurious insects, and secondly, the useful insects, such as predaceous and parasitic species. As regards classification I have followed Lefroy's arrangement in *Indian Insect Life*. The predaceous and parasitic Coleoptera under this treatment appear therefore in their correct positions in the system of classification. Each one, however, is dealt with again and in fuller detail in the section treating of the pest upon which it is predaceous or parasitic, its life history and other particulars following that of its host. Each insect considered in the work is dealt with, so far as possible, under the heads distribution, trees attacked, description of the species, life history, relations to the forest, and, where practicable, remarks on protective and remedial measures for combating its attacks.

The compilation of the work has proved more intricate than was at first deemed probable, and has been dependent throughout on obtaining the identification of the insects upon which it is based. Dr. A. E. Shipley, Mr. Guy A. K. Marshall, and Dr. R. Steuart MacDougall, who kindly looked through the proofs early in 1912, strongly advised my securing the description of all new species and full identifications (not merely generic ones) of every insect dealt with. This advice, which was acted upon, led to a lengthy but quite unavoidable delay in the publication of the book—a delay which, I am assured, is fully justified.

Without the unstinted and enthusiastic help that has been accorded me by a large number of friends, the book, imperfect as all pioneer works of necessity must be, would never have assumed its present shape.

The systematic study of forest insect pests may be said to owe its origin to Sir Thomas Holderness, K.C.S.I., Permanent Under-Secretary of State for India, at the time Revenue-Secretary to the Government of India, and the late Sir Denzil Ibbetson, K.C.S.I., Revenue Member of Council. It was due to their recognition of the importance of the study of this branch of forest science being undertaken, when the

matter was laid before them by Mr. B. Ribbentrop, C.I.E., at the time Inspector-General of Forests, that the first foundations were laid, the Secretary of State sanctioning in 1900 the first appointment, that of the Author, of a Forest Entomologist for a period of two years. This post was resanctioned in 1904, as a result of the earnest representations of Mr. (now Sir) Sainthill Eardley Wilmot, then Inspector-General of Forests, and subsequently merged in 1906 in that of Forest Zoologist in the newly created Imperial Forest Research Institute.

For the exceptional opportunities afforded me of personally collecting so much of the information the book contains during extensive tours made throughout the whole of India and Burma, my thanks and acknowledgments are due to five successive Inspectors-General of Forests: Messrs. B. Ribbentrop, C.I.E.; H. Hill, C.I.E.; R. C. Wroughton; Sir Sainthill Eardley Wilmot, K.C.I.E.; and Mr. F. Beadon Bryant, C.S.I. To Sir Sainthill, under whom I had the good fortune to work directly during six years, I owe a deep debt for advice and assistance at all times cordially given to me. To the direct representations of Mr. Beadon Bryant, at the time Inspector-General of Forests, the department owes the fact that the sanction of the Government of India was accorded to the preparation of the work, and that I was allowed to have free access to the collections of the Forest Research Institute at Dehra Dun. My acknowledgments are also due to the present Inspector-General of Forests, Mr. G. S. Hart, C.I.E.; to the President of the Institute, Mr. L. Mercer, C.I.E.; and to the late Forest Zoologists, Mr. Subramarian Iyer and Dr. A. D. Imms, for the valuable assistance afforded me by the loan of such specimens, tour notes, and files as were required for the work.

Allusion has been already made to the great assistance received from officers of the department. I would like to express my acknowledgments here to the Service throughout, and more especially to Messrs. J. W. Oliver, J. H. Lace, C.I.E., B. B. Osmaston, F. Gleadow, P. M. Lushington, W. F. Perrée, P. H. Clutterbuck, C. G. Rogers, S. Carr, G. M. Ryan, A. V. Monro, T. A. Hauxwell, and the late Mr. H. Slade, Conservators of Forests; to Messrs. H. G. Billson, R. C. Milward, S. Cox, C. B. Smales, R. S. Hole, B. O. Coventry, C. E. C. Fischer, C. P. Percival, A. J. Gibson, T. Carr, A. E. Osmaston, and the late A. M. Long and J. Messer, Deputy-Conservators of Forests; and to Bhai Sadhu Singh, Rai Bahadur, Pandit Gokal Dass, and Messrs. V. Subramarian Iyer, B. Sen Gupta, Rama Nath Mukerjee, the late Mr. J. P. Gregson, and Messrs. A. M. Littlewood and Young, of the Provincial Service.

From officers in other Services I have received great help at various times. During my work in Baluchistan in 1905 I received the greatest assistance from the Agent to the Governor-General, Mr. A. L. P. Tucker, C.I.E.; Lieut.-General Sir H. L. Smith-Dorrien, G.C.B., D.S.O.,

at the time commanding the Quetta Brigade; Colonel C. Archer, C.S.I., C.I.E. (now Agent to the Governor-General in Baluchistan); Colonel G. Chevenix Trench, C.I.E., and Colonel C. A. Kemball, C.I.E., both of the Political Department; Major (now Colonel) R. E. Roome, Commandant of the Zhob Levy Corps; and Captain E. H. S. James, of the Political Department. My thanks are also due to the Raja of Chamba State for the facilities kindly placed at my disposal during my tour there in 1909. To the many officers in the Civil Service through whose divisions and districts I toured throughout the country my thanks are due for the cordial assistance always afforded me. I would also wish to thank here my old head clerk Babu A. T. Das, and my tour clerk Babu Nilumbar Dut, to whom I feel I am greatly indebted.

During the compilation of the work I have received valuable counsel and advice from Dr. A. E. Shipley, F.R.S., Master, Christ's College, Cambridge; from Mr. Guy A. K. Marshall, of the Entomological Research Committee; and Dr. R. Steuart MacDougall, Lecturer in Forest Zoology at the University of Edinburgh, and a Member of the Entomological Research Committee. Mr. Marshall has added to the obligations under which he has laid me by undertaking a considerable amount of identification work besides working out the Curculionidae and describing several new species.

In the Insect Department of the Natural History Museum, South Kensington, I have received unstinted help. Mr. C. J. Gahan, Keeper of the Department, identified the Cerambycidae; Mr. Gilbert Arrow some of the lamellicorns; Mr. K. G. Blair described several new Tenebrionidae, and Mr. R. Meade-Waldo dealt with the Hymenoptera. Mr. Claude Morley kindly undertook the Ichneumonidae, describing new species. For several years past my friend Mr. G. Lewis, F.L.S., has been good enough to determine Histeridae for me.

My sincere acknowledgments are also due to Monsieur P. Lesne, of the Paris Museum, who named the Bostrychidae, and to Monsieur G. Severin, Conservator of the Brussels Museum of Natural History. In Brussels Monsieur Severin undertook to get named a considerable portion of the collections, and to have drawings prepared where required. The following gentlemen, to whom my grateful acknowledgments are due, helped in this work: MM. Fleutiaux, F. Ohaus, H. Gebien, R. Gestro, A. Grouvelle, S. Schenkling, M. Maindron, A. d'Orchymont, M. Pic, M. Burr, and C. Kerremans, who described a new buprestid.

In connection with the work on the Scolytidae and Platypodidae, two families which occupy considerably over a fourth of the book, my intention had been to deal with the whole collection myself. My appointment as Head of the Department of Forestry at Edinburgh University resulted in my having reluctantly to give up this idea. To

Colonel F. Winn Sampson I owe a deep debt of thanks for so kindly coming to my assistance and undertaking to deal with the identification work connected with the *Xylebori* and the Platypodidae for me, several new species of which he has described. To Dr. Max Hagedorn, an authority of world-wide reputation in these families, I owe thanks for his kindly help and advice.

To Sir William Schlich, K.C.I.E., F.R.S., my old Professor of Forestry at the Royal Indian Engineering College, Coopers Hill, and to Mr. Walter F. H. Blandford, Lecturer in Forest Entomology at the college, my acknowledgments are due for the encouragement I received at their hands to prosecute my studies in this branch of forest science. I retain the liveliest feelings of gratitude to Sir William for the interest he has evinced in me, and for the praise and congratulations he has given me in my forestry career.

As regards the illustrations, the frontispiece and coloured plates Nos. xxviii, liii, and lviii are from the able brush of my wife; Nos. xi and xxv by Mr. A. Descubes; No. xv and a considerable proportion of the figures in the text by Mr. Horace Knight, to whom my thanks are due for his excellent work. Most of the uncoloured plates were drawn by the artists J. Singh, S. B. Mondul, and S. C. Mondul. The greater number of the photographs were taken by Mr. Chitrakar, Photographer to the Research Institute.

Lastly, my most cordial acknowledgments are due to Mr. William Foster, C.I.E., Registrar and Superintendent of Records at the India Office; to Mr. H. Mitchell, Assistant Registrar; and to Mr. E. W. Jolliffe, for the great trouble they have taken in matters connected with the preparation of the book. To Mr. Foster it would be difficult to express my recognition of the cordial and unwearying interest he has taken in the work.

To Messrs. Eyre & Spottiswoode, the printers, to their staff, and to the reproducers of the plates and figures I would tender an expression of my admiration and praise for the workmanlike manner in which they have dealt with the work, and for the very high efficiency of their proof-readers.

EDWARD PERCY STEBBING.

University of Edinburgh,
18 *May* 1914.

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INDIAN FOREST INSECTS

OF ECONOMIC IMPORTANCE.

CHAPTER I.

ON A STUDY OF THE DISTRIBUTION OF THE INSECT FAUNA OF INDIAN FORESTS.

THE work of investigation into the life histories of the insect pests of the extensive Indian forests, forests covering an area whose climate varies from tropical to sub-arctic, is yet in its pioneer stage. It will be readily understood that the character and composition of forests growing under such varied climatic conditions must of necessity differ enormously: from the coniferous and broad-leaved (oak, chestnut, etc.) forests of the Himalaya, through the forests of the hot dry zone, to those of the hot moist, finally merging into the mangrove forests of the seaboard. And this change in the vegetation is accompanied by a difference in the species and genera—in some instances, it may be said, families—of the insects which infest the trees growing in a particular area.

Gamble has stated * that the Indian forests contain some five thousand different species of trees, shrubs, climbers, and bamboos, covering about one-third of the Indian flora. With this large number of species in the forest to deal with, the investigator into the life histories of the insects infesting them would also expect to find, with each change in the forest flora, a corresponding change in the species or group of species of insects infesting the trees of a particular locality. And this, to a certain extent, so far as present investigation work has been taken, has proved to be the case.

It is too early yet to draw out a distribution list of the chief important pests of the different classes of forest throughout the country, but a commencement in this direction may be attempted.

The work of the past decade and a half has made it possible to give broadly the limits within which some of the insect pests of the different kinds of forest commit their depredations, i.e. the area within whose boundaries their attacks must be feared as those of dangerous foes. It will be useful, therefore, as a preliminary to an account of the injurious insects at present known, to glance briefly at the distribution of a few of

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* J. S. Gamble, *Manual of Indian Timbers*, Intro. p. xxii.

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the families or genera or individual species which are already, or are likely to become in the future, of chief importance to the executive forest officer.

When a distribution list of forest pests was first attempted it was considered possible that the forest tracts might be divided for this purpose broadly into those of the hot dry region, those of the hot moist region, those of the regions intermediate between these two, and those of the Western and Eastern Himalaya and contiguous mountain ranges. Or that, failing such a classification, a distribution could be based on the classes of forest, i.e. the areas occupied by the chief species of trees at present economically useful to the forester. A distribution list based on either of these factors has been found to be impracticable. Whilst some genera or species, it is true, seem to be confined to the hot dry localities or the hot moist ones, others appear to flourish in both. We know that the habitat of the same species of tree may vary from a comparatively hot dry climate to a hot moist one, as, e.g., the sál (*Shorea robusta*) in the Central Provinces and in Assam. It would therefore perhaps be natural to expect that an insect which infested the tree in the hot dry climate could also adapt itself to the hot moist one. And this is true of some species, but not of others. For instance, the sál longicorn beetle *Hoplocerambyx spinicornis* infests this tree both in the Central Provinces and Assam, but the beetle also extends down into the Shan Hills far beyond the distribution limit of the sál, and here attacks the *Duabanga sonnatioides* and *Pentacme suavis*. On the other hand, the sál-tree extends into Northern India and forms forests in the Terai in the foothills of the Western Himalaya. The *Hoplocerambyx* does not, however, follow the sál into this locality, its place being taken by another longicorn, *Æolesthes holosericea*. As a logical sequence to the distribution of this and other species, which will be dealt with later, it would appear that the distribution of forest insects is limited more by cold and elevation than by heat and moisture.

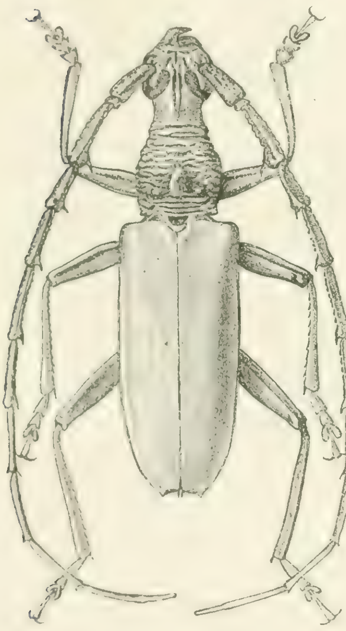


FIG. 1.—*Hoplocerambyx spinicornis.* Newn. ♂ × [illegible]. (F.B.I.)

Or, to put it in another way, beyond a certain elevation in the Himalaya and other elevated mountainous tracts to the south the forest pests of the plains are rarely found, whereas south of the Himalaya below a certain elevation some pests may have a very wide distribution, both in hot dry and hot moist localities, whilst others will be confined either to the forests in hot dry localities or be restricted to the hot moist areas. We will briefly consider this distribution in the plains.

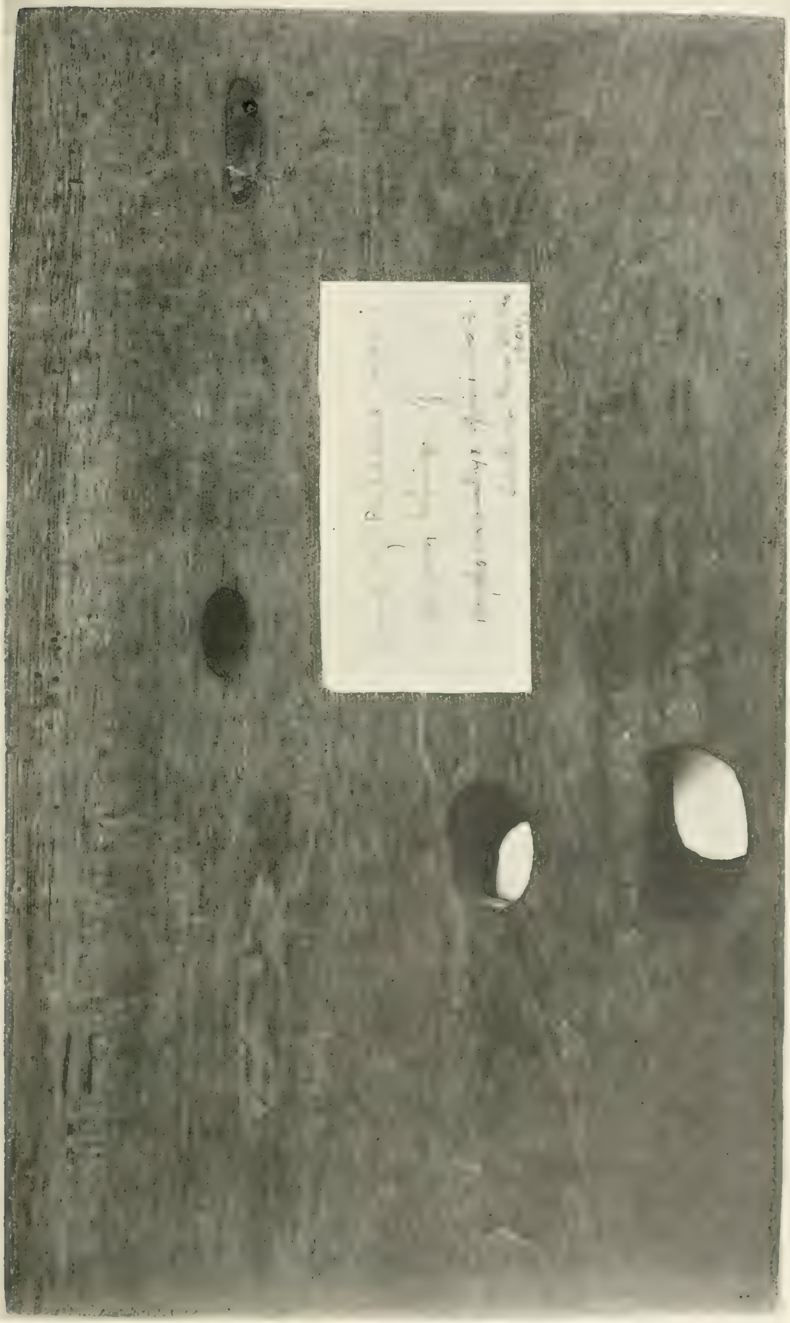


FIG. 2.—Section of wood of *Pentacme suavis* showing borings of *Hoplocerambyx spinicornis*, Newn. Southern Shan States.

As a first case, a tree may have a wide distribution, and its particular pest may accompany it throughout. This is true of the tun-tree (*Cedrela toona*) twig-borer, *Hypsipyla robusta*, which appears to be as widely distributed as the tree itself. I have personally taken the insect from twigs and branches at Changa Manga in the Punjab, in the United Provinces, Central Provinces, Bengal, and at Maymyo in Upper Burma. Similarly the two well-known defoliators of teak, the caterpillars of the moths *Hyblæa puera* and *Pyrausta machaeralis*, appear to be found wherever the tree exists as a forest in India, i.e. in Bombay, Central Provinces, Madras, and Burma.

Or a pest may infest a variety of trees occupying very different climates, and have itself a wide distribution. Amongst the family Bostrychidae instances are common. Both *Sinoxylon crassum* and *S. anale* infest several species of trees, tunnelling into and riddling their timber. These beetles occur as a serious pest in the Changa Manga plantations, where they infest sissu (*Dalbergia sissoo*) and *Acacia modesta*. I have also taken one or other or both of the insects in sál, *Terminalia tomentosa*, *Acacia catechu*, *Anogeissus*, *Pterocarpus*, *Albizzia*, *Prosopis*, etc., in the forests of the United Provinces, Bombay, Sind, the Central Provinces, Assam, and Burma. Again, the genus *Dinoderus* includes two species, *Dinoderus pilifrons* and *D. minutus*, one or other or both of which are to be found infesting bamboos throughout the length and breadth of India.

Caryoborus gonagra again (one of the Bruchidae) infests the seeds of a variety of trees, and appears to be equally at home in Bombay, the Central Provinces, and Madras. The common noctuid caterpillar *Ingura subapicalis* defoliates the sál in Ganjam, and also in the United Provinces Terai and Oudh forests in the monsoon months.

On the other hand, to come to our other case, there is an assemblage of moths belonging to the families Lasiocampidae and Noctuidae which defoliate the sál-tree in the Central Provinces and Chota Nagpur (species of *Trabala*, *Ingura*, etc.). In the sál forests of the United Provinces Terai the Central Provinces species are replaced by others (*Suana*, *Boarmia*); whilst again in Assam an entirely different set of defoliating caterpillars are met with on the sál, several species of *Lymantria*, *Dasychira*, *Leucoma*, etc.

To quote one more instance amongst plains insects, a genus of bark beetles, *Sphaerotrypes*, which infests the sál-tree, has this local distribution. *S. siwalikensis* is found infesting the sál of the Siwaliks and United Provinces Terai. A second species, *S. globulus*, is found in the Central Provinces on the same tree; whilst a third species, *S. assamensis*, infests the sál in Assam. A fourth species attacks the *Anogeissus latifolia* in Coimbatore in Madras. It is unnecessary here to dwell on further instances of the anomalies in the distribution of some of our forest species in the plains, as they will be alluded to at length later on.

Turning now to the insects of the Himalayan forests, investigation has shown that the assemblage of insect pests present in the Western Himalaya

differs greatly from that in the Eastern portions of the range. And this is only what might be expected, since the composition of the forest in the two localities is entirely different. In the Western Himalaya, as compared with the broad-leaved assemblage of species characteristic of the Eastern, the coniferous forests predominate, and we find classes of pests more resembling those of the European, American, or Japanese coniferous areas. Here again anomalies are found in the distribution of genera and species, and even families. The importance of the families Bostrychidae, Buprestidae, and Cerambycidae, all powerful groups in the plains, has disappeared. Serious pests, small in size, there are in the two latter families, as witness the deodar buprestid *Sphenoptera aterrima* and longicorn *Trinophyllum cribratum*, and the long-leaved pine *Nothorrhina*. But the great importance of the families as evidenced in the plains forest has been outclassed here by the Scolytidae. This family in the Western Himalaya contains an assemblage of pests who have at their mercy the whole of the coniferous species, and in every instance, so far as present investigations go, the species affecting a particular tree accompanies it from the centre to the limits of its habitat. Another point about the distribution of some of these genera, which is known to be the case in other parts of the world, is that one or more appear to be confined to a particular species of tree. There are, e.g., three species of *Scolytus* known in the Western Himalaya (*S. major*, *S. minor*, and *S. deodara*), and they all infest the deodar. I have never yet taken the genus from any other tree in the Himalaya, nor have I found it at all in the plains. And yet in Europe the genus is confined to broad-leaved trees! We must look to America for analogous instances of its infesting conifers. There is a *Polygraphus* (*P. major*), it is true, which will also infest the deodar, but only when it is unable to find a sufficiency of its own real host, the blue pine. The important genus *Tomicus*, on the other hand, does not appear to infest the deodar. One species (*T. ribbentropi*) attacks both blue pine (often in company with *Polygraphus pini*) and spruce (but not

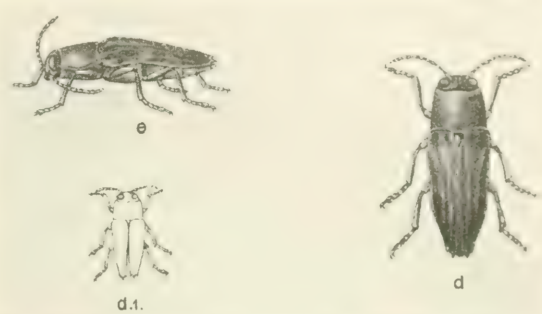


FIG. 3.—*Sphenoptera aterrima*, Kerrem.
d I natural size, *d e* enlarged.

FIG. 4.—*Polygraphus major*, Steb. × 10.

the silver fir); whilst a second confines itself to the long-leaved pine (*Pinus longifolia*) at the lower elevation at which this latter tree grows.

A family of wood-borers, the Platypodidae, closely allied to the Scolytidae, has a similar distribution, one species being confined to the deodar, a second to the spruce and blue pine, whilst a third restricts its attacks to the long-leaved pine, whose wood it frequently so riddles with shot-holes as to render it useless as timber.

FIG. 5.—Egg and larval galleries of *Tomicus longifolia*, Steb., in inner bark of *Pinus longifolia*. North-West Himalaya.

The bark-borers of the silver fir are, on the other hand, totally dissimilar to those of the other conifers growing either with it, as does the spruce, or in its vicinity (deodar and blue pine). The curious genus *Scolytoplatypus* (p. 604) infests the wood of this tree; whilst the genus *Xyleborus* infests the branches (p. 582); a species of *Dryocoetes* infests the bast and sapwood of the spruce (p. 549).

Some of the true scolytid wood-borers and those of the Cossonidae have not this restricted distribution so far as their host-trees are concerned, for species of *Hylastes* and *Rhyncholus* infest equally the spruce, deodar, and blue pine. A genus of weevils, the well-known *Cryptorhynchus*, infests

.H.Lace Photo.

Fig 1. GALLERIES OF THE BLUE PINE [illegible], [illegible]

Figs 2,3,4. GALLERIES OF *POLYGRAPHUS PINI* [illegible]

p, PAIRING CHAMBER; *e*, EGG GALLERY; *l*, LARVAL GALLERY

the Himalayan pines, but two different species of the genus infest the three pines—the blue pine, long-leaved pine, and the *Pinus khasya* of Assam and Upper Burma.

But whilst such marked limits can be placed upon the distribution and host-plants of many of the coniferous bark-boring pests in the Western Himalaya, the same limits cannot be assigned to the distribution of some of the predaceous pests infesting them. For instance, the clerid *Thanasimus himalayensis* preys equally upon all the various species of bark- and wood-borers infesting the deodar, spruce, blue pine, and long-leaved pine in the Western Himalaya, appearing equally at home between elevations of 2,500 ft. and 8,000 ft. A *Niponius* also (*N. canalicollis*, of the family Histeridae) preys upon the larvae and pupae of these bark-borers, and is to be found not only in the above-enumerated conifers, but also in the *Pinus gerardiana* in the Suliman Mountains in Baluchistan, where it preys upon the *Polygraphus* (*P. trenchi*) which infests the pine in this locality. A curious distribution, since the genus is a Japanese one.

FIG. 6.—*Niponius canalicollis*, Lewis.

It may be mentioned that another member of this genus (*N. andrewesi*) is to be found preying upon the sál-tree *Sphaerotrypes* both in the Siwaliks and United Provinces Terai, in the Central Provinces sál areas, and again in Assam, whilst in Coimbatore it attacks the *Sphaerotrypes* of the *Anogeissus*.

Although I would not be understood to say that they do not occur, I have not found the genera *Polygraphus* and *Tomicus* in the plains forest, their places being apparently taken by the genus *Sphaerotrypes*.

Per contra, I have not found that the bostrychid genera *Dinoderus* and *Sinoxylon* extend to a great elevation, beyond 4,000 ft. probably, in the Western Himalaya. A species of *Sinoxylon* has been reported from the Darjeeling *district* in the Eastern Himalaya, but the locality is not recorded, and the district extends down to the plains. These two genera appear to be particularly addicted to great heat requirements, either dry or moist.

From the above brief *résumé* of the distribution of a few of the more typical forest pests it will be apparent that it would be difficult to base a distribution of certain groups of insects or of certain families, genera, or species, either upon the species of trees they infest or upon certain classes of mixed forests in which they attack the predominant species and some of those others which are normally found in mixture with it; for it has been shown that the distribution of the particular insect may extend far beyond the limits of the predominant tree. Nor is it possible to base a distribution, in the light of our present knowledge, on particular zones of vegetation, such as a hot dry one, hot moist, etc.; for certain species

appear to be at home both in a hot dry climate and in a hot moist one. Finally, it is not possible to base a distribution list on the species of trees attacked. In the coniferous areas of the Western Himalaya it is apparent to some extent that certain species of one or more genera are confined to certain species of tree; in some cases a genus may be confined to a particular tree; or another genus and certain species in it may infest more than one species of tree; or, lastly, to one or two species of trees one or more species in one or more genera may confine their attacks.

In the case of predaceous insects instances are known where a particular species is found throughout the plains forests attacking a certain genus of bark beetles, its distribution apparently depending on the distribution of the genus upon which it preys.

CHAPTER II.

GENERAL REMARKS ON INJURIOUS AND BENEFICIAL INSECTS.

I.—General Remarks on the Different Methods by which Insects Attack and Destroy Tree Growth and the Different Parts of the Tree Affected. —Damage done to (*a*) Roots; (*b*) Stems: (1) Young Trees, (2) Poles, (3) Old Stems; (*c*) Branches; (*d*) Young Twigs; (*e*) Buds; (*f*) Leaves; (*g*) Inflorescence; (*h*) Fruits and Seeds; (*i*) Timber.

II.—General Remarks on the Methods by which the Insects of Use to the Forester accomplish their Work.—(*a*) Predators, or insects which prey directly upon injurious insects, which they consume at once as food; (*b*) Parasites, or insects which live parasitically upon injurious species, slowly killing them.

I.—General Remarks on the Different Methods by which Insects Attack and Destroy Tree Growth.

Specific Account of the kinds of Damage that may be done.

The tree may be injured or killed in various ways by the insect. The nature of the injury done depends upon two principal things—

(1) The nature of the aggressor, whether it belongs to the great group of biting insects or to the equally dangerous section which live by suction.

(2) The method of growth of the tree and the nature of its parts, whether more or less resistant to insect life or favourable for its sustenance.

1. The Nature of the Aggressor.

As we have seen, for our purpose insects may be divided into two groups, the biting insects and the sucking insects.

It will be obvious that whereas it is a simple matter for an insect provided with a strong pair of biting jaws or mandibles to bore through the old, dead, thick outer bark of a tree to get at the cambium layer beneath, such a procedure would be quite impossible for an insect like an aphis or plant blight, which takes its sustenance through a soft tubular beak and is without strong biting jaws.

Therefore, the nature of the mouth-parts present in the insect determines to a great extent the part or parts of the tree it is able to attack.

(*a*) **Biting Insects.**—An insect furnished with biting mouth-parts is able to attack every part of the tree from root to fruit or seed. As we shall see,

insects so formed commit serious damage to the bast and wood of the roots, main stem, and branches of the tree. To mention but a few instances, members of the families Siricidae (Hymenoptera); Buprestidae (p. 190), Cerambycidae (p. 268), Scolytidae (p. 457) (Coleoptera); Cossidae, and Arbelidae (Lepidoptera), do such damage either in their larval or imagine stages. Other species live in the bast or interior of the smaller branches and twigs: Scolytidae: Pyralidae (Lepidoptera), for instance; whilst others again feed on the leaves or needles of the tree: sawflies (Tenthredinidae); Chrysomelidae (p. 253), Curculionidae (p. 393) (Coleoptera); Lymantriidae, Noctuidae, Pyralidae (Lepidoptera). Finally, other biting insects destroy the flowers or fruits: Chrysomelidae, Cantharidae (p. 246), or tunnel into the seeds, as for example members of such families as the Bruchidae (p. 250), Curculionidae, Scolytidae; Pyralidâe, Microlepidoptera (Lepidoptera).

(*b*) **Sucking Insects.**—The powers of the sucking insect to damage the tree are somewhat more restricted, since it is unable to attack such portions as are coated with thick bark, save where it can obtain ingress to the bast layer through wounds, a fruitful source of attack. The area of the tree open to attack is, however, still of very considerable extent, consisting as it does of the whole of the crown and the smaller roots; and, of course, seedlings and young saplings are subject to injury in every part. In the case of some trees, all the conifers for example, the injury possible from the sucking insect is of very considerable extent.

The younger roots are subject to the attacks of one of the worst families of sucking insects, the plant lice or Aphidae (Rhynchota). The roots may also be galled and consequently weakened under the attacks of Chalcidae (Hymenoptera), Aphidae, and Coccidae (Rhynchota).

The stems, branches, twigs, and leaves, are subject to direct attack by tapping or suction by Aphidae and Coccidae. Or, again, galls may be produced on any of these parts by Chalcidae, Curculionidae, Aphidae, and Coccidae.

Similarly the flowers and seed may be either directly tapped by the chalcid, aphid, or coccid family, or they may be indirectly affected and the seed aborted or rendered barren by the insidious tapping of the sap of the flower-bearing twigs by members of these families.

2. The Method of Growth of the Tree and Nature of its Parts.

This section may be prefaced with the remark that in nature the balance between the tree and the insect is held fairly even. A primeval forest always contains a number of sickly and dying trees, which provide sufficient food for the insects who prey upon the particular species of tree. It is usually, not always, only when man interferes with nature's balance of power that serious insect invasions in the forests are experienced. This

is commonly the case when the tree is encouraged to grow pure in dense masses.

Trees grow in different ways, and have in some cases acquired characters more or less resistant to insect attacks. For instance, the thick bark of some of the conifers offers impediments to the burrowing propensities of certain Scolytidae, although others are not deterred by its presence. *Polygraphus major*, a scolytid beetle which attacks the blue pine (*Pinus excelsa*), only infests the branches and upper portions of the main stem. It is never found burrowing into the thick bark of the tree. Similarly, although it also infests the deodar (*Cedrus deodara*), it only attacks young saplings and seedlings, and is much less happy in this tree, finding the bark and wood too hard for its purpose. Again, the thick rough bark of the *Pinus longifolia* serves as a deterrent to several bark-beetles which are confined to the smaller branches and twigs of the tree.

Fig. 7. Young deodar root girdled by root-feeding caterpillar.

The conifers when attacked or wounded have the power of exuding masses of resin which are obnoxious to most mature forms of insect life, although the grubs of the same species can exist and flourish in this resin. Numbers of the smaller Buprestidae, Cerambycidae, and most species of the Scolytidae which infest Coniferae, are drowned in the outflow of resin put out in response to the tunnelling operations of these insects. The species alluded to tunnel down into the bast (or wood) to prepare galleries in which to lay their eggs. Healthy trees respond to the burrowing of the insect by an outflow of resin which fills the tunnel and drowns the insects. It is only when a tree is so sickly that it has lost the power to answer to such attacks by an outflow of resin in sufficient quantity that the beetles gain the upper hand and kill it.

Again, the thick bark of a tree or the thick shell or coat of the fruit or seed

FIG. 8. Root of *Acacia arabica* tunnelled by *Coelosterna scabrata*. Beetle *in situ* in pupal chamber. Berar.

protects them from the attacks of the gall-making insects and from the tapping operations of the plant-lice (aphids) and coccids or scale insects, and from the attacks of the bark-eating caterpillars, which can only attack the softer parts of the tree. In many cases the thinner bark, leaves, flowers, and seeds contain substances such as unpalatable sap, oils, etc., which are distasteful or inimical to insect life, such trees proving more or less immune to serious attack.

We turn now to consider briefly the damage which may be done to the individual parts of the tree.

(*a*) **Damage done to the Roots.**—Probably greater damage is done to the roots of forest trees in India than the forester has as yet any suspicion of. The thicker roots of the sál-tree are subject to the attacks of Cerambycidae (*Hoplocerambyx*, p. 320) and, in the portions contiguous to the trunk, of Scolytidae (*Sphaerotrypes*, p. 481), whilst the bark of the smaller roots is eaten by various species of Melolonthinae (Cockchafers, p. 73).

The roots of young seedlings and saplings of another broad-leaved tree, the babul (*Acacia arabica*), are tunnelled into and destroyed by a cerambyx beetle (*Coelosterna*, p. 358), whilst those of young poplar saplings are tunnelled by the caterpillar of a moth (*Trochilium omnatiaeforme*), and those of the sandal-wood (*Santalum album*) by another lepidopterous caterpillar (*Zeuzera coffaea*).

The roots of deodar seedlings are cut through by the coleopterous wireworm (*Elater*, p. 230) and the

lepidopterous cutworm (*Agrotis*), or girdled by other lepidopterous caterpillars (cf. fig. 7).

The smaller roots of the deodar are subject to the attacks of at least one aphid, and probably other trees are infested in this way by this family, whilst the gall-making families also infest the roots.

Casuarina seedlings are destroyed by the grubs of the rhinoceros beetle (*Oryctes*, p. 87).

(*b*) **Damage done to the Stem.**—(1) *Young Trees.*—The stems of young trees are subject to attack in a variety of ways: The young seedling may be destroyed *in toto* by Orthopterous insects such as locusts (Acridiidae) and crickets (*Brachytrupes*); the green bark and bast may be stripped off them by locusts in the case of *Pinus longifolia*, and Coleoptera such as Buprestidae (*Psiloptera*, p. 199) in the babul, and Cerambycidae (*Apriona*, p. 374) in the mulberry; or it may be ringed, as, for example, *Poinciana* by *Xylotrupes* (p. 90), deodar by *Scolytus deodara* (p. 578), and casuarina by *Arbela tetraonis*.

The bast may be tunnelled and destroyed by Scolytidae, examples of which are *Polygraphus major* (p. 501), in the deodar and blue pine; Curculionidae, such as *Cryptorhynchus* (p. 428), in the *Pinus longifolia* and *Pinus khasya*.

The bast may be tapped by numerous Aphidae, such as the Black Aphid of the blue pine, the Aphid of the *Pinus longifolia*, the *Chermes* and *Lachnus* of the silver fir, the *Chermes* of the spruce, and the coccid *Monophlebus* of the sál, teak, sissu, and other trees.

(2) *Poles.*—The stems of poles are subject to attack by many of the insects which infest young trees. Their lower parts are, however, covered by a thicker bark, and this leads to their infestation by species which will not attack younger trees.

For example, sál poles may have both bast and wood riddled by cerambyx beetles (*Hoplocerambyx* and *Æolesthes*), and the bast consumed by Scolytidae (*Sphaerotrypes*). Teak is tunnelled by the bee hole-borer caterpillar (*Duomitus*) and the kulsi-borer (*Stromatium*, p. 293).

The bast of deodar poles is riddled by *Scolytus major* (p. 568) and *Scolytus minor* (p. 577); also by *Polygraphus major* (Scolytidae).

(3) *Old Stems.*—The number of insects which infest the main bole of old trees is very large.

The sál, in different parts of the country, has to contend against two large species of cerambycid beetles (*Hoplocerambyx* and *Æolesthes*) which riddle the bast and tunnel deep into the hard wood of green trees; other species of the family destroy the bast only. Two or three species of *Sphaerotrypes* act in the same manner.

The bast of the teak-tree is eaten by the caterpillar of *Duomitus ceramicus*, the grub tunnelling into the wood to pupate; with the subsequent growth of the tree the tunnels become enclosed in the wood, ruining it for large timber purposes. Species of the genus *Xyleborus* (Scolytidae, p. 582) tunnel down into the timber.

Poplar and willow are killed and the wood destroyed by the grubs of the cerambycid beetle *Aeolesthes sarta* (p. 307).

The bast of green deodar is destroyed by the buprestid *Sphenoptera* (p. 204), by the cerambycid *Trinophyllum* (p. 340), and by the scolytid beetles *Scolytus major* and *S. minor*, and the wood of the tree is tunnelled into by the wood-borer *Crossotarsus* (p. 613).

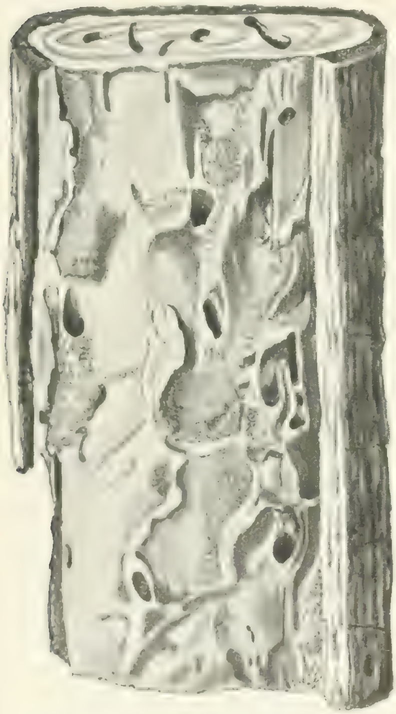


FIG. 9.—Larval galleries of *Hoplocerambyx spinicornis*, Newn., in bast and sapwood of sál (much reduced).

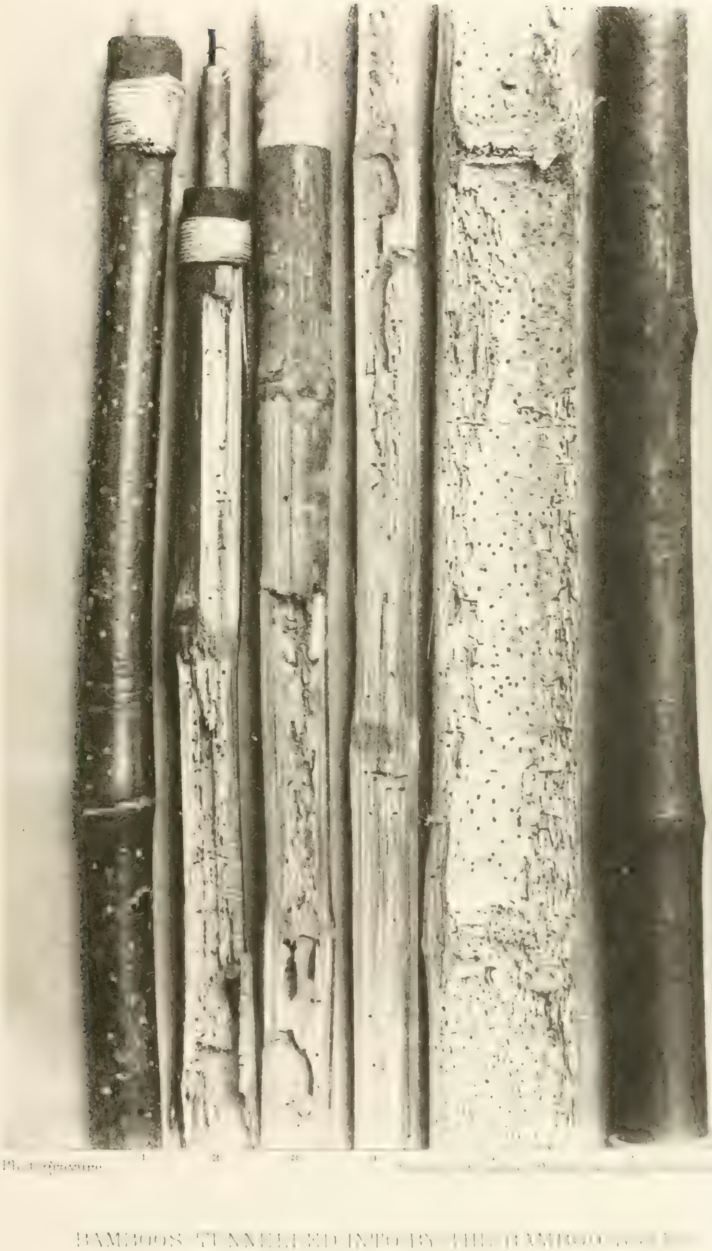
The bast of the *Pinus gerardiana* is riddled and the tree often killed by the beetle *Polygraphus trenchi* (p. 510).

To quote two more instances, the wood of the sissu, acacia, *Terminalia*, etc., is riddled by the wood-borers *Sinoxylon crassum* and *S. anale* (p. 152) and bamboos by *Dinoderus* (p. 133 and pl. ii).

(*c*) **Damage done to the Branches.**—The larger branches of the tree, covered by old thick bark, are tunnelled into and destroyed by most of the insects, both bast-eating and wood-boring, which infest the main stem.

Where the bark commences to thin out, the insects we have already mentioned as infesting poles will be found to be present, and they occupy all the part of the crown up to the twigs. A little experience will show that the dividing lines between the species infesting the areas covered by old thick bark, thin younger bark, and the green cortex-covered twigs, are very fairly sharply marked off, each having their own set of insects. There are, however, some pests which infest every part of the tree with the exception of the young green cortex-covered twigs.

The branches of the sál-tree are infested by a small buprestid beetle, *Acmaeodera* (p. 193), and by a cerambycid, *Xylotrechus* (p. 347). The twigs and young saplings of the sál-tree suffer severely from the tapping propensities of the *Monophlebus* scale insect.



Photogravure 1 2 3 4

BAMBOOS TUNNELLED INTO BY THE BAMBOO

(*d*) **Damage done to the Young Twigs.**—The young twigs have a set of pests which usually confine themselves to these parts of the tree. Some of them will also be found to infest seedlings and saplings.

The smaller branches and twigs of the tun-tree are tunnelled and destroyed by the tun-tree borer (*Hypsipyla*).

Scolytus minor is to be found in the bast of deodar twigs, both in saplings and old trees, whilst a smaller scolytid (p. 528) is to be found mining the smaller twigs.

The twigs of the spruce and silver fir suffer from the attacks of a *Chermes* (*C. himalayensis*), which forms galls upon and aborts and kills the former, whilst curling up and killing the latter.

The *Pinus longifolia* suffers from a pyralid caterpillar which hollows out the extremities of the branches and kills them.

The twigs of the teak, *Boswellia*, *Pinus longifolia*, silver fir, blue pine, etc., are destroyed by tiny scolytid pests (*Cryphalus*, *Pityophthorus*, pp. 533, 551).

(*e*) **Damage done to the Buds.**—The buds of forest trees doubtless suffer a very considerable amount of as yet unappreciated injury from insects.

The buds of the sál in Assam are destroyed by a small microlepidopterous caterpillar.

It is on the winter bud of the spruce that the *Chermes* winter female feeds, and sets up an irritation which subsequently results in a gall enclosing her progeny, the bud being entirely destroyed.

Fig. 10.—Inner surface of the bark of *Pinus gerardiana*, showing the egg and larval galleries of *Polygraphus trenchi*, Steb.

The buds of *Pinus longifolia* suffer from the attacks of a cecidomyid fly which causes pseudo-galls to be formed.

(*f*) **Damage done to the Leaves.**—Everyone is acquainted with the damage done to the leaves of trees by insects. The result is commonly seen in the ragged edges of partially eaten leaves, in holes eaten out of the inner portions, in the epidermis of the upper or lower surface being eaten, or the parenchyma between the epidermis being consumed or mined by tunnels, in the leaf being "skeletonized," the parenchyma being eaten and the veins left, or finally in entirely defoliated trees. Or again a great web like a gigantic mass of spiders'-webs is seen in the branches of a tree, the leaves in its vicinity being probably mostly stripped off. This is the home of a society of what have been called the "tent caterpillars," because they thus live together, for a portion of this stage of their existence, in a kind of immense house or tent, usually issuing out to feed at night.

The insect pests which feed upon the leaves of the forest trees are legion. Some of the more important are now known. For instance, the sál-tree in Assam is at times entirely stripped of all green leaves over hundreds of square miles of country by species of caterpillars belonging to the family Lymantriidae (*Lymantria* spp.). In the United Provinces the same tree suffers from the attacks of the looper caterpillar *Boarmia selenaria*, and from those of the noctuid moth *Ingura subapicalis*, whilst in the Central Provinces, again, the larvae of the latter and of the moths *Lymantria semicincta*, *Trabala vishnu*, and *Suana* sp. are the worst defoliators of the tree. The defoliation to which the teak-tree is subject from the larvae of the moths *Hyblæa puera* and *Pyrausta machaeralis* is well known. Large forests of this tree in the Central Provinces, Bombay, Madras, and Burma are at times completely defoliated, or the leaves are skeletonized and killed by one or both of these species working together.

The deodar in the North-West Himalayan forests is occasionally stripped of its needles by a species of geometrid caterpillar (*Geometrina*), blocks of forest being completely defoliated.

The oaks (*Quercus incana*, *Q. dilatata*, and *Q. semicarpifolia*) of these Himalayan areas are also defoliated by species of *Tortrix* and *Tinea* caterpillars, whilst the horse-chestnut is occasionally completely defoliated by the caterpillars of the moth *Acronycta anaedina*. The looper grubs of the moth *Bistria suppressaria* defoliate several species of trees in the Murree hills.

Again, the oak (*Q. lamellosa*) of the Darjeeling forests in the Eastern Himalaya is defoliated by the caterpillars of species of *Gazalina*.

But defoliation is not always the result of caterpillar attacks. The sissu in the Sutlej Valley, and probably throughout the North-West Himalayan valleys, is defoliated by a small weevil named *Apoderus* (p. 418).

Many of the Chrysomelidae beetles feed upon leaves, such as the *Podontia* beetle (p. 258) which defoliates the *Spondias mangiferae* and *Ficus elastica*; and an Aphis so reduces the vitality of the needle-bearing twigs of the blue pine that the needles fall either wholly or in part. These are but a few instances of the serious defoliation to which trees are subject by insect pests.

(*g*) **Damage done to the Inflorescence.**—It is probable that the inflorescence suffers very seriously from the attacks of insects. I have as yet but a few actually observed examples. The commonest form of attack is for the eggs to be deposited in or on the inflorescence, and for the resulting grubs to mature in and gradually destroy the developing fruit or seed.

The blister beetle (*Mylabris*, p. 247) actually feeds upon and destroys the flowers of the *Artocarpus* and many shrubs such as the *Hibiscus*, etc.

The caterpillars of the moth *Boarmia selenaria* devour the inflorescence of the sál-tree in the forests of the United Provinces Terai and Siwalik areas.

(*h*) **Damage done to the Fruits and Seeds.**—A great deal of investigation work remains to be carried out in the study of the damage done by insects to the fruits and seeds of forest trees in India. Sál seed in Assam is infested by the caterpillars of several species of small moths (*Conogethes*, *Laspeyresia*, and *Cacoecia*), and also by a small scolytid beetle (*Coccotrypes*, p. 543). In the United Provinces and Siwaliks the caterpillars of other species of moths (the pyralid *Dichrocosis leptalis* and Microlepidoptera) are responsible for the failure of what may promise to be a good seed year.

The cones of the chief conifers of the North-West Himalayan forests, the deodar, silver fir, spruce, and blue pine, are infested by one or both of the caterpillars of the moths *Phycita abietella* and *Euzophera cedrella*.

The *Quercus incana* seed is infested by a small weevil, *Calandra*, p. 446. Small bruchid beetles, species of *Caryoborus*, are responsible for damage to the seed of *Bauhinia*, *Tamarindus*, *Cassia*, whilst the small caterpillars of the moths *Trachylepidea fructicasiella* and *Cryptophlebia carpophaga* infest the seeds in the long pods of *Cassia fistula* and *C. occidentalis*.

The acorns of the oak *Q. semicarpifolia* are destroyed by the grubs of the hymenopterous fly *Callirhytis semicarpifoliae*.

(*i*) **Damage done to the Timber.**—Every forester is aware that once the tree is dead the timber is liable to a more or less rapid decay, the rapidity depending to some extent on climatic and surrounding influences. In India a variety of insects play a very important part in assisting this falling off in quality of the timber. The attacks of others lower the market value of the timber owing to the presence of galleries and holes on the outer sapwood or in the heart-wood, as in the case of the sandalwood longicorn beetle (cf. pl. III and p. 380). The number of timber-boring insects is very large, some of the chief pests being found in the families Bostrychidae, Elateridae, Cerambycidae, Curculionidae, Scolytidae, Platypodidae, Termitidae, Siricidae, Cossidae, etc.

II.—General Remarks on the Methods by which the Insects of Use to the Forester accomplish their Work.

The insects of use to the forester may kill either the egg, larva, pupa, or imago stage of the host insect upon which they prey, or they may destroy more than one of these stages of their host.

(*a*) Predators, or Insects which prey directly upon injurious forest insect pests which they comsume at once as food.

Investigation in the Indian forests has shown that the forester is assisted in his work of protecting the trees from injury by a variety of insect helpers.

Up in the North-Western Himalaya probably one of the chief insects of importance in this category is the scolytid bark- and wood-borer predator *Thanasimus himalayensis* (p. 186), discovered in 1902, the imago of which feeds voraciously upon most of the Himalayan coniferous bark- and wood-boring scolytids. This insect takes the place of the well-known *Clerus formicarius* of the German coniferous areas. The grubs of this beetle (which preys upon the scolytids outside the tree) feed upon the bark-beetle grubs in their tunnels in the bast layer.

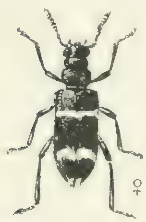


Fig. 11.—*Thanasimus himalayensis*, Steb., predaceous upon Scolytidae in the Western Himalaya.

A second species of the same family, *Tillus*, enters the tunnels of the bamboo-borer *Dinoderus minutus*, and feeds upon the larvae and pupae of this bostrychid (*vide* p. 186).

Another useful bark-beetle predator in these forests is the histerid *Niponius canalicollis*, first discovered in 1901. This beetle follows the bark-beetles into their tunnels, notably *Scolytus* and *Polygraphus*, and preys upon the eggs and grubs and pupae in one or more of the metamorphoses. Another species of the same genus preys in a similar manner upon the sál *Sphaerotrypes* beetles in the United Provinces and Assam, and upon the *Sphaerotrypes* of the *Anogeissus* in Madras. Several other histerids (*Paromalus, Platysoma*) prey in a similar manner upon the scolytid bark-borers *Polygraphus* and *Tomicus*, and upon the wood-borers *Rhyncholus* and *Hylastes*. Other histerids, again, species of the genus *Teretriosoma* (p. 104), prey upon the bostrychid wood-borers *Sinoxylon crassum* (p. 152) and *S. anale* (p 167), which infest the sissu-tree.

Observations carried out over a period of ten years have, I think, established the fact that certain species of histerids have adapted their mode of life to that of the insects upon which they prey. Those species, so far as at present observed, which prey upon bark-boring Scolytidae obtain entrance to the tree by crawling down the tunnels made by their hosts. Species of *Niponius, Platysoma, Paromalus, Teretriosoma, Teretrius,* all act in this manner. This point is further referred to under the family.

Section of a sandal-wood log showing the larval galleries of [illegible] sp. in the outer sapwood. The presence of these galleries greatly reduces the sale price of the wood. North Coimbatore, Madras, 1902.

The large ground-beetle *Anthia sexguttata* (p. 95) feeds upon the caterpillars of the hawk moth *Pseudosphinx* in Berar and Bombay, upon *Sinoxylon* (p. 173), and probably upon other insects.

A species of *Bothrideres* (p. 112) preys upon the grubs of the cerambyx beetle *Hoplocerambyx* in Assam, whilst another destroys the wood-borer *Sinoxylon*, as also do species of *Alindria* (p. 114) and *Melambia* (p. 114).

Another coleopterous genus, *Hectarthrum* (p. 116), preys upon the *Sinoxylon* wood-borers in the Central Provinces, upon platypid borers (p. 611) and termites in *Miluisa* and *Anogeissus* in Lower Burma, and upon the *Dinoderus* bamboo-borers (p. 140).

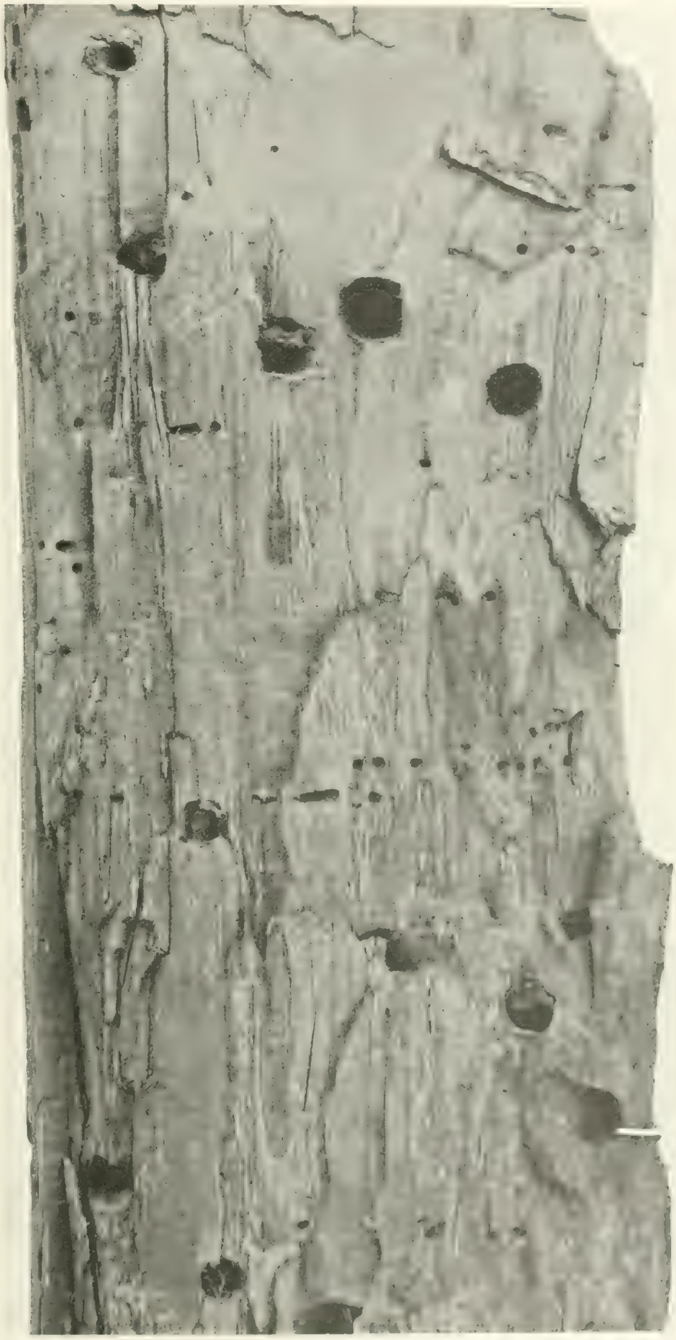


FIG. 12.—Portion of stem of a dead *Dalbergia* sp., showing the large pupating chambers in the wood of the elater *Alaus putridus*, and the tunnels and entrance bores of a platypid beetle in the timber.

Small bast-living forms of the Staphylinidae also prey upon various scolytid bark-borers or their grubs.

FIG. 13.—*Hectarthrum uniforme*, Waterh., which preys upon termites in *Miluisa velutina* in Tenasserim.

Many of the Coccinellidae are active predators both in the grub and beetle stage. For instance, the coccinellid *Vedalia* (p. 125) preys upon the sál coccid scale insect *Monophlebus stebbingii*, whilst the cosmopolitan *Coccinella septempunctata* (p. 123) preys upon the Aphis of the blue pine, the *Lachnus* of the silver fir, and upon the young grubs of the *Chermes himalayensis*.

The beetle *Cissites* (p. 248) oviposits in the tunnels of the carpenter bee, *Xylocopa latipes*, in pyinkadu, its grubs feeding upon those of the latter.

Finally, to come to the Rhynchota, the bug *Erthesina fullo* feeds upon the caterpillars of the sál-defoliator *Boarmia selenaria* in the United Provinces Terai forests.

(*b*) PARASITES, OR INSECTS WHICH LIVE PARASITICALLY UPON INJURIOUS SPECIES, SLOWLY KILLING THEM.

The number of insect parasites, as also of that far less-known branch, the fungus parasites, of the insect world is very great. The forester, and more especially the forester in India, where the individual charges are of such vast size and the forests of such enormous extent, is very largly dependent upon the parasites which decimate and keep in check the insect foes of his trees. It is therefore of considerable importance that he should be able to recognize the presence and abundance of such valuable coadjutors in his work of protection. That this is by no means a difficult feat will soon become evident to the forest-trained eye. One has only to repair to a felling area, and carefully scrutinize felled trees which have been lying in the forest from two to three weeks with the bark on. The presence of various bark-borers will soon be noted, intent on tunnelling into the tree to eat out their egg-galleries in which to oviposit, or crawling over the bark searching for a favourable spot to start their tunnelling operations. In the Western Himalaya the predator *Thanasimus* may be noted flying round or running quickly up the bark, searching eagerly for the bark-beetles. Watch closely and you will see numbers of minute flies hovering about, or settling upon the bark and disappearing down the entrances to the tunnels made by bark-beetles who have already got well down through the bark and reached the bast. These flies are parasitic insects, the friends of the forester. They creep down the tunnels of the bark-borers and lay their eggs in the galleries in the bast. The young grubs, on hatching from these eggs, feed parasitically upon the grubs of the bark-borer, clinging

to them as external parasites and gradually sucking their life out. Or, again, the mother fly may deposit her egg or eggs actually in the grubs of the host insect through a small orifice pricked in the skin. The parasitic grubs will then live inside the host-grubs as internal parasites.

Some of these parasites of wood-infesting insects are of considerable size, and may be specially furnished with a long apparatus at the end of the body termed an ovipositor. This the female inserts down through crevices of thick-barked trees such as the spruce of the Western Himalaya, so as to reach the egg or young larva of the host. An example of this class is the *Rhyssa* Ichneumon which parasitizes the *Sirex* saw-fly.

It will be found to be a common rule in the case of many of these parasitic grubs that they do not immediately kill the host-grub. The latter grows on until it reaches full size and has carried out all its duties up to the preparation of the pupal chamber. The larva gradually grows feebler and feebler, and, finally, its work done, dies of exhaustion. The parasitic grub has by then reached full growth, and pupates in the pupal chamber of its host, the fly maturing here and escaping from the trees by various methods, which differ for different species, to seek out a mate, when the cycle is commenced over again.

FIG. 14.—*Rhyssa persuasoria*, Linn., parasitic on *Sirex imperialis*. N.W. Himalaya.

The large number of parasites which prey upon caterpillars live in much the same way, usually as internal parasites. When the caterpillar has reached full growth and dies of exhaustion, they may pierce through its dried skin and pupate outside close by, or they may wait till the caterpillar has formed its chrysalis case. The caterpillar pupa then dies and shrivels up inside, its place being occupied by the now fully-grown parasitic grub (or grubs), which pupates inside the chrysalis case.

A few instances of useful parasites to the forester may be quoted as examples.

The order Hymenoptera contains families of great importance in this direction; the Ichneumonidae, Chalcididae, and Braconidae, for instance.

Species of Ichneumon of use in the forest are numerous.

Rhyssa persuasoria is parasitic upon the grubs of the *Sirex imperialis*, which tunnel into spruce timber. Its grubs live as external parasites and accompany the *Sirex* grubs into the heart of the tree.

A species of Ichneumon, a small fly, lays its eggs in the tunnels of the deodar pest, *Scolytus major* (p. 568), the grub also feeding as an external parasite upon the bark-borer grub.

Other species of Chalcid and *Pompilius* are parasitic upon the *Polygraphus* and *Tomicus* bark-boring beetles (pp. 519 and 556).

The Ichneumon *Ephialtes viridipennis* is parasitic upon the deodar buprestid *Sphenoptera* (p. 204).

Another Ichneumon, *Ophion aureolatus*, Cameron, is parasitic upon the horse-chestnut defoliator, *Acronycta anaedina*.

Species of *Glypta* and *Pimpla* are parasitic upon the caterpillars of the teak defoliator, *Hyblæa puera*.

A species of *Meteones* is parasitic upon the caterpillar (*Tinea* sp.) defoliating the Kharshu oak, *Q. semicarpifolia*.

Species of Chalcididae are parasitic upon *Polygraphus major* (p. 507) and upon defoliating *Lymantria* caterpillars in Assam.

Again, a small Bracon fly is parasitic upon the bark-beetle *Scolytus minor* (p. 577).

A small two-winged fly, like the ordinary house-fly, a species of *Mascicera* (Diptera), is parasitic upon the teak-defoliator *Hyblæa puera*, whilst another species of probably the same genus is parasitic upon the caterpillars of the moth *Eublemma amabilis* which feed parasitically upon the lac insect (*Tachardia lacca*).

A species of *Trigonomerus* is parasitic upon the *Pinus longifolia Cecidomyia* fly.

CHAPTER III.

ON SOME METHODS BY WHICH THE PRESENCE OF INSECT PESTS IN THE FOREST MAY BE ASCERTAINED, AND THEIR LIFE HISTORIES AND MODES OF ATTACKING TREES STUDIED.

One of the commonest ways in which forest insects bring themselves into prominence, and one which must have made itself evident to all forest officers, is by entering the bungalow at night, owing to the attraction lights have for this class of animal life. Now, information of a very important nature may be gained from these nocturnal visitations: I mean of importance to the forester, for the appearance of a particular insect signifies that at this period of the year it has arrived at the mature stage of its metamorphosis, and that it is now probably engaged in egg-laying in the forest, and for this purpose, if a tree pest, is in search of trees in a state suitable for its requirements. Thus, by noting these dates of appearance we secure some very important information—first, in many cases, the date of appearance of the insect on the wing, or one of these dates should the particular insect pass through more than one generation or life-cycle in the year; secondly, the date or approximate date on which the eggs are laid in the trees, since in many cases but a short period is passed in the mature stage of its existence by the insect, the longer period being in either the egg, grub (most usual), or pupa period of its metamorphosis; thirdly, we may, and very often do, secure the approximate date on which the young grubs or larvae hatch out from the eggs, observation having shown that in many cases, notably in the case of the more dangerous of the wood- and bark-boring beetles, but a short period, often forty-eight to sixty hours or even less, elapses between the deposition of the egg and the hatching out of the grub from it.

We thus see that even the appearance of a particular species or several species at the office or dinner-table may, if taken advantage of and provided the specimen is kept and its identification secured, lead to information of the highest importance to the forester being placed upon record.

Similar observations may be made whilst engaged in executive work in the forest. An insect which makes its presence noteworthy in a locality owing to its abundance or for any other reason should be at once secured; the date of collection, locality, and class of forest, with species of trees it was frequenting or *appeared* to be frequenting, should be at once noted down, and every effort made to ensure the identification of the species. It is almost impossible for

FIG. 15.—Portion of stem of a Rhododendron, showing numerous larval galleries of a buprestid in the outer sapwood. N.W. Himalaya.

the executive officer to gauge the vast importance a note recorded in such a manner may have in the future, provided it has been sent for record to the expert in charge of this particular branch of forest work. It may perhaps prove the connecting link the latter has been seeking for several years, the link which pieces together a whole chain of notes and observations waiting this one important point to complete it. It has been often said that there is little use in recording such notes or in collecting the insects, since very often no identification of the insect can be given. The remark has in many

instances proved all too true. But it must be remembered that the study of the insect pests of the Indian forests is still in the pioneer stage. Some considerable collections of forest insects—minute insects as many of our tree pests are — were forwarded to the British Museum in 1901. The answer came back that a large percentage of the species appeared new to the Museum collections. Several of them are still without a specific name. Investigation work and collection work carried out since then has tended to show that the insect fauna of our forests, or perhaps it would be more correct to say the insect fauna of our trees, is practically a new field of research, a field as interesting as it is arduous. So far as has been ascertained, a considerable proportion of the species of importance to the forester have yet to be described; and such descriptions, depending, as they must do, upon the convenience of the savants who devote their life's work to the particular family or group to which they belong, must be awaited with patience. This does not, however, prevent our endeavouring to ascertain the life histories of these insects in the forest, and to find out exactly how they affect the forest officer. There are at the present moment several examples of pests whose life histories are more or less completely known, but which still await a specific name. This, however, is also the case with some of our less well-known forest trees.

It is not, perhaps, surprising that so many of the insects living in and affecting the growth or destroying the trees of the Indian forests should have remained up till now unknown, since it may be taken as a general rule that—

(1) Many of the insects whose grubs feed in the bast or wood of trees are nocturnal and usually only appear upon the wing at night, when they leave the trees on maturing, and then for only a comparatively short period, from a few hours to a week or two at most. Many Cerambycidae and Scolytidae only leave the trees in which they were reared at night, and then fly off in search of recently felled trees or sickly standing trees, where they pair either outside the tree or after they have tunnelled into it. If they pair outside the tree they hide during the daytime in the shade of felled trees on the surface of the bark nearest the ground; or they hide in the thick scrub jungle or beneath pieces of bark, stones, or other refuse on the floor of the forest during the daytime, and lay their eggs in the crevices of the bark of sickly standing trees at night. As these insects do not appear naturally on the wing during the daytime they have not been caught by ordinary collectors, and so have not reached European collections in the manner in which many of the insects of the non-afforested areas have.

(2) Many of the worst pests of the trees of the forest are minute inconspicuous insects which have remained uncollected, and so unnamed up to date. The family Scolytidae, containing large numbers of tiny insects very difficult of classification, and yet of the very greatest importance to the well-being of the Indian forests, is a case in point.

Fig. 16.—Central vertical egg-galleries from which radiate the larval galleries made in the outer sapwood of a sál-tree by the bark beetle *Sphaerotrypes*.

(3) The insect fauna of the Indian forests has never till within the last few years been systematically collected.

The life histories of many of the forest-living insects are of uncommon interest, and in nothing perhaps are they so remarkable as for the instinct which many of them seem to possess—many beetles, for example, such as the Buprestidae, Cerambycidae, and Scolytidae, to instance three important families only — which enables them to seek out newly felled or sickly dying trees in as unerring a manner as that of the soaring vulture in his detection of the newly dead carcase. Nothing can be more striking than this wonderful power. Inspect a felling area a few days or a week or two after the trees have been cut. If you examine the bark of a felled tree you will perceive on its outer surface numerous shot-holes, or numbers of little cones of sawdust, or small patches of sawdust. Take off a strip of the bark and examine it on the inside. You will find on it, and perhaps on the outer surface of the sapwood, small galleries or plans of several galleries, and in them perhaps one or two small blackish beetles, and at the head of the still incomplete off-set galleries small whitish dots, one at the head of each little gallery (cf. frontispiece). The little beetles are bark beetles (Scolytidae), and the little grubs have already hatched out from the eggs laid

W. F. Perrée, photo.

Section of the trunk of a green sál-tree badly infested by *Hoplocerambyx spinicornis*, Newn. Living beetles are present in the pupal chambers, which are closed by the white calcareous coverings. Goalpara, Assam, 1906.

by the beetles. The species in question, which in most cases will vary with the species of tree you are examining, will only attack fresh green sappy bast, and by some unerring instinct it is always able to discover for its egg-laying operations newly felled trees, if haply there be such in the area; or if in a forest untouched and untended by man, new windfalls or sickly, unhealthy, or dying trees. If such are perchance unavailable, it must go to the green healthy standing trees to oviposit, since dead trees with no fresh sappy liber in them are useless for its purpose, as they would afford no sustenance to the young grubs when they hatch from the egg.

Many of the Buprestidae and Cerambycidae are also possessed of this wonderful instinct for detecting newly felled trees. Whilst on tour in Goalpara in May 1906 several green perfectly healthy sál-trees were felled in the forest one morning. On visiting the trees the following morning in company with the Divisional Forest Officer, Mr. W. F. Perrée, we found a hundred or two of the large longicorn beetle *Hoplocerambyx spinicornis* crawling about in the shade of the outside bark nearest the ground at points where the bark did not actually rest on the soil. Until we parted the undergrowth surrounding the fallen trunk the insects were in complete darkness, and they were all perceived to be intent on pairing or egg-laying. This proved the first recorded instance of the operation of egg-laying by longicorn beetles in the Indian forest having been observed. Further careful examination showed that the forest contained hundreds and thousands of these beetles; and yet there was no sign of them whatever until sought for in their day shelters, as the insect is not a diurnal one. I would not be understood to say that there are no diurnal longicorns. There are. The brightly coloured *Thysia wallichii* is a case in point, and we saw some specimens of it sitting in the sunlight on adjacent standing sál-trees on the morning in question. This instance is quoted to show that it is quite possible for the forester to find some of his pests in the forest during the day, if he knows where to search for them, and so to make himself acquainted with their abundance at the seasons at which they are on the wing and egg-laying. He is thus in a position to know what to expect in the way of insect attacks during the next few months. In the case of the *Hoplocerambyx* in question, the insect was proved to be in enormous numbers, and its life history being understood, the early barking of all felled trees became imperative, since it was known that once the grub

FIG. 17. *Thysia wallichii*, a diurnal longicorn. Assam.

had got down into the wood the barking would be too late to prevent its subsequent tunnelling operations into the heart-wood, and that all timber containing these grubs would be rendered unfit for sale purposes.

We come then to the next point—that a knowledge of the life histories of the more dangerous of the tree pests of his locality is essential to the Forest Officer if he is to be in a position to—

(1) Prevent serious attacks to the standing crop resulting in the loss of many individual trees or of whole blocks of forest, with the consequent upsetting of his working plan. The tremendous damage Scolytidae are capable of committing in coniferous areas is a well-known example.

(2) Prevent his timber being destroyed by insects after the trees have been felled in the forest for sale purposes. That this is possible the *Hoplocerambyx* example already quoted renders evident.

How are the life histories of tree pests to be ascertained?

Some insects only attack young seedlings. Close observation by officers in charge of nurseries, assisted by careful inspection of areas of sowings in the forest, will enable the life histories of these pests to be ascertained. There is urgent need that such observations should be carried out. For some years it has been an acknowledged fact that deodar seed sown in lines or patches in the forest has completely failed. The young seedlings may have come up only to gradually die off and disappear.

Observations have shown that a melolonthid or cockchafer grub (p. 82), a wireworm (*Elater*, p. 230), and a cut-worm caterpillar (*Agrotis*), are responsible for a great deal of this mysterious disappearance of sowings.

Other insects only attack the leaves, buds, or flowers and fruits and seeds of the trees. The working out of the life histories of such pests requires close observation and investigation to be undertaken in the forest at the times when such attacks are being experienced.

Another class whose attacks are often only too visible in the tree, although it is extremely difficult to track down and secure the identification of the mature insect, is that of the bark-eating and wood-boring caterpillars. The caterpillars themselves can be secured, but the identification of the particular pest cannot be undertaken from the caterpillar. The grub only feeds upon the juicy bast layer and the sap-filled sapwood, subsequent "weathering" often setting up at the place attacked (cf. fig. 18). The grub may sometimes, as in the case of the bee-hole borer of teak (*Duomitus ceramicus*), tunnel down into the hard dry wood to pupate, but only when full-fed, and for pupating purposes alone. How to secure the mature stage or moth of these bark-eating and wood-eating caterpillars is a difficult problem. If one cuts the stem down and keeps a section in which the caterpillar is known to be, as soon as the latter finds the bast or wood beginning to lose its sap and dry up it comes to the outside and

usually dies there, or if it pupates the moth very rarely matures so as to be recognizable. If the caterpillar has pupated the pupal chamber contracts as the wood dries and shrinks, and the pupa is killed or the moth is deformed and unrecognizable. A useful plan to obtain the moth (and it can be made to apply to securing some of the bast- and sapwood-feeding beetles also) is to envelop the part of the stem of a tree in which you have marked down one of these pests with mosquito-netting, tying it tightly above and below round the bark, and catch the moth when it issues in this manner; or cut the whole tree into sections and place them in a large insectary or breeding cage, and catch the moths as they issue from the stems, as I was able to do with the moths *Duomitus ceramicus* and *D. leuconotus*.

FIG. 18.—"Weathering" action set up in the sapwood of a teak tree at the point of attack of the caterpillar of *Duomitus ceramicus*. *A*, the point at which the grub tunnelled into the wood to pupate.

Fortunately, however, some of the most serious of forest pests, the large class of bark- and wood-boring insects (and their predators and parasitic foes, the friends of the forester), can be studied by every Forest Officer out in the forest in a comparatively simple manner.

All that is required is that two or three green healthy trees of the species whose pests it is wished to study should be felled in some convenient locality. The trees should not be felled in deep shade, nor in positions in which they will receive the full force of the midday sun, which will dry them up too quickly.

By visiting such trees, say, weekly or fortnightly, and stripping off a piece of bark so as to examine the bast layer on its inner side and the outer sapwood on the stem itself, a vast amount of information of importance to the Forest Officer can be ascertained.

The common bast-eating beetles who infest this particular tree will quickly make their appearance—buprestid, cerambycid, and scolytid, perhaps also elaterid and curculionid. The insects appearing will of course be the mature forms only, and they will at once commence egg-laying on the outer bark, or in crevices in the bark, or tunnel into the tree and eat out the pairing-chambers and egg-galleries in the bast and sapwood. The dates of such operations should be noted. If the inner side of the bark (the bast) is examined, small elongated galleries may be observable with a series of little notches set therein at regular intervals all the way up on either side (cf. fig. 22). These are made by bark beetles, Scolytidae, and in each notch is an egg. Careful observation may also show the presence of several of the insect friends of the forester. The clerid *Thanasimus* (p. 186), for instance, may be present on the outside of the bark, or the *Niponius* (p. 103) in one or more of the egg-galleries of the bark beetles, or numerous tiny airy flies hovering about, Ichneumons (p. 474), Chalcids (p. 507), or Bracons (p. 480), all parasitic upon the insect pests, and all there with intent to lay their eggs in the galleries of the bark-boring insects.

Little individual galleries half an inch or less may be visible already in the sapwood, made by buprestid or cerambycid grubs.

The visit made a fortnight later will show many more galleries present in the inner surface of the bark; and those first observed will now have numerous off-shoot galleries on either side made by the grubs which have hatched out from the eggs laid by the bark beetles. At the head of each a grub will be seen. The buprestid and longicorn grubs will also be larger and their galleries longer and broader. Amongst the numerous galleries pink larvae may be seen. These are predaceous *Thanasimus* or *Niponius* larvae feeding upon the bark-beetle ones. Or tiny white maggots may be visible attached to some of the bark-boring grubs (cf. fig. 360) or to the buprestid or cerambyx grubs. These are parasitic grubs hatched from the eggs of the Ichneumon, Bracon, and other flies we saw hovering about on our first visit.

Four weeks later an inspection may show that the scolytid grubs have reached full size and have turned into pupae at the end of their galleries. The parasitic larvae and the *Xiponius* ones may also have pupated in the galleries.

Some six weeks or two months after our first visit to the tree, we may find the plan of the galleries of the bark beetle complete, and at the end of each larval gallery will be a pupa, white in colour and having some resemblance to the beetle, or a beetle itself complete in every detail. This will mean that the life-cycle of that particular insect has been watched from start to finish. In other words we shall have proved that in all probability that particular species passes through more than one life-cycle or generation in the year; and its life history will not be completely known until we have ascertained how many of these life-cycles it passes through in this period.

In most cases it will be useless to watch for further generations in the tree in which the one cycle has been reared. The bast layer will now be too dry, except perhaps at the thicker butt end, where some of the insects of the new generation may tunnel in to oviposit. It is a safer plan to fell two more trees close by as soon as you see your beetles nearly mature and ready to leave the first trees.

The first generation of beetles on leaving your first set of trees will repair to the second set to oviposit, and your observations may now be transferred there for the next period. Some of these bark beetles pass through from three to five generations in the year, and this will entail felling from three to five series of trees in order to definitely ascertain the correct number. All that is necessary is to wait till the beetles of a particular generation you are watching in the trees become nearly black in their pupal chambers, and then fell your next series of trees.

With the maturing of our first lot of beetles in the first series of trees, our observations in this series will not have come to an end, however. Maturing with them, we must remember, will be their insect foes the predaceous pink larvae and the parasitic grubs. Careful observations will, therefore, enable us not only to ascertain the life history of the particular bark beetle we are studying, but also at the same time that of one or more of its insect enemies. For instance, you may find one or more *Xiponius* beetles easily recognizable from the bark beetle in the galleries; or at the end of one or more larval galleries you may see a small papery cocoon, which on being opened is seen to contain a tiny Ichneumon, Chalcid, or Bracon fly, perfectly developed and just ready to issue. For it appears to be a general rule that many of these bark- and wood-boring insect parasites pass through a similar number of generations to that of their insect hosts; a fact which would seem to be within the bounds of probability.

We have not yet done with the first series of trees, however; they still have in them the buprestid and longicorn grubs, whose growth is much

slower than the much smaller bark-beetle ones. These grubs may take six, eight, or ten months to reach full size in the bast and sapwood, and then they will be found to have disappeared from view, as they will bore tunnels into the sapwood or even into the heart-wood in which to pupate (cf. pl. iv). Here they will remain for two or more months, and then the mature beetle will crawl up the tunnel, eat a hole through the old bark above, and escape from the tree.

The gradual maturing of the pupa into the beetle can be ascertained by chipping down one of the tunnels and exposing the elongate pupal chamber at its lower end and observing the condition of the insect in it. The mature beetle, from its colouring, hardness, and powers of movement, will be readily distinguishable from the inanimate pupa or the still soft, light-coloured, immature beetle.

Thus it is evident that, whilst the first beetles observed to enter the tree after felling, the bark beetles, may mature and leave the tree within two months of its being felled, the slower developing buprestid and longicorn beetles may require the whole year to pass through their life-cycle. Consequently, these beetles will only be found on the wing in the forest and egg-laying once in the year; and should it not be their egg-laying season when our first series of trees are felled, they will not appear in them, and may not appear until two or more series of our trees have been cut.

Two practical illustrations of this method of ascertaining the life histories of insect pests in the forests may be quoted here.

1. Life History of *Sphaerotrypes siwalikensis*, Steb.

The life history of this scolytid bark-borer was worked out in the sál forests of the Siwalik Division in the United Provinces.

The observations were commenced in September 1901, when the Divisional Officer, Mr. R. C. Milward, I.F.S., at my request kindly had a couple of green sál-trees felled for me.

The observations were carried out with the aid of the Range Officer, and every fortnight until the following May, when the transfer of the ranger led to their discontinuance for a time, visits were paid to the trees, or the successive series of trees felled as required, and specimens of all insects found in them were bottled and the tubes labelled and sent in to me at Dehra. During this period I also visited the trees on several occasions. Subsequent investigations undertaken between May and September enabled the full observations for the year round to be carried out.

From these detailed investigations the life history of this important sál bark beetle (see page 476) has been fully worked out, as also that of several of its parasitic and predaceous foes.

2. Life History of the buprestid *Sphenoptera aterrima* and the cerambycid *Trinophyllum cribratum*.

Green deodar-trees were felled under the orders of the Divisional Officer, Mr. V. Munro, at the end of May 1908, and watched throughout the year and up to June of the following year. The observations so made and the specimens taken enabled the life histories of these two pests to be definitely ascertained. It is now known that each takes a whole year to pass through one life-cycle (cf. p. 205 and p. 341), and that the beetles mature and leave the trees at the end of May or in the first fortnight of June, and lay their eggs in newly felled fresh sappy trees or in standing green sickly ones.

The life history of an Ichneumon fly, *Ephialtes*, which parasitizes the buprestid grub has also been worked out through the year (see p. 207).

The importance of thus investigating the life histories of all the principal bark- and wood-feeding pests of the more important trees cannot be too strongly insisted upon.

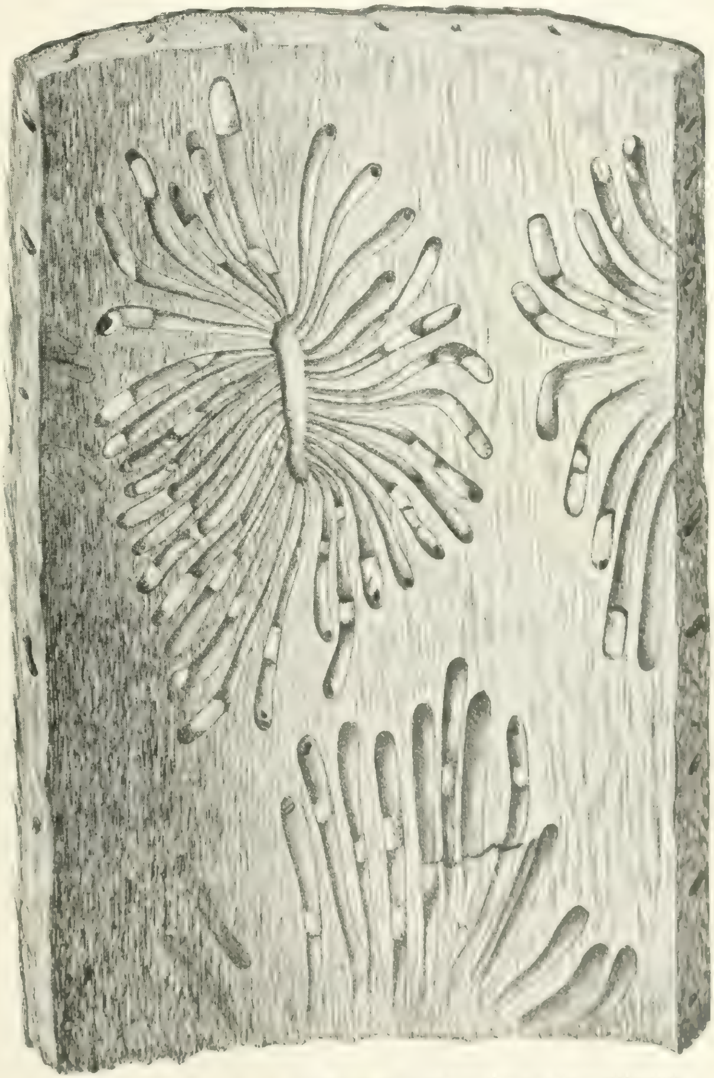


FIG. 19.—Egg and larval galleries of *Sphaerotrypes siwalikensis*. Steb., on inner surface of sál bark, showing the "plan" of the galleries.

That the work is a comparatively simple one to put through will be fairly obvious from the above descriptions of the methods necessary to undertake it. Many of the head-quarter houses of the Range Officers are situated in the immediate vicinity of the forests under their charge. By felling a couple of trees somewhere close to the range house they would be able to visit the trees twice a month without any very serious interruption to their executive duties. The value of the observations they would thus be able to record is almost incalculable, and would result in the local Forest Officer soon being placed in the possession of the life histories of all his more serious pests. This of course presupposes that a course of Forest Zoology is included in the education of the Range Officer.

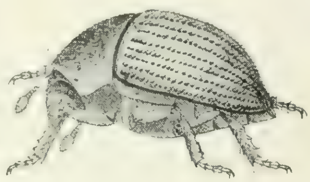


FIG. 20.—*Sphaerotrypes siwalikensis*, Steb. × 10.
A sál-tree bark-borer. Siwaliks, N. India.

CHAPTER IV.

ON METHODS OF PREVENTING INSECT ATTACKS IN THE FOREST AND OF COMBATING THOSE TAKING PLACE.

1.—Liability of Forests to Insect Invasion.

It has been often remarked in India in the past, that there is little danger of serious insect invasions being experienced in the forests of the country—serious enough, that is, to kill off the trees over large areas. It has also

Fig. 21. —Chilgoza pine-trees infested and killed by the bark-borer *Polygraphus trenchi*, Steb. Zhob, Baluchistan.

been repeatedly said that even were such attacks experienced, it would be impossible to do anything to combat the insects or save the trees. In the past I admit there was much apparent reason to support such statements. The forests had been taken over by the department for the most part in a hopeless state of mismanagement, and many had all the appearance of being ruined for good. It is not surprising that under these conditions to worry about attacks of insect pests taking place in devastated woods was

considered an absurdity. The work of the past half-century has, however, entirely changed the position of affairs and the condition and appearance of many of the forests. What formerly had all the appearance of being worthless waste lands have now become well-ordered estates of considerable and increasing value. What were once disorganized, almost disforested (so far as valuable timber went) areas are now being brought under fine normal crops of valuable timber of an almost incalculable value to the well-being of the country at large.

The time, therefore, when the officers of the department could afford to regard with tranquillity the possibility of insect invasion as a danger not of their time or day is past. In the well-ordered management of the forests which has now taken the place of the chaos which formerly reigned, in the yearly increasing density of the crops per acre compared with what formerly stood there under the conditions pertaining to primeval forests and in the period which followed when many of the forests had been cut out, in the careful fire-protection instituted over large areas throughout the country, and finally with the vagaries of the Indian climate ever holding the country at their mercy and leading to unprecedented increases in the numbers of a pest at a few short weeks' or months' notice in the event of the occurrence of an unusually dry season or series of dry seasons—in all these influences we see the scale turned against the forest and in favour of the insect, and it cannot therefore be too strongly emphasized that the day of immunity from insect attacks on a large scale in the forests of India is rapidly drawing to a close.

What is the experience of the world ?

The European forest management, that of Germany and France, has been held up to the Indian Forest Service as the ideal to aim at. But neither in Germany nor France have they been able to reduce the science of forestry to such a degree of exactitude as to prevent serious plagues of insects from devastating the forests. And this with a sound knowledge of forestry science, and a plethora of specialists at their back. They know how to combat a serious attack in Germany and France ; they know how to recognize it in its earliest phases, and so how to reduce its effects and the resultant monetary loss to a minimum. But they cannot foretell an attack before it has actually begun, or is about to commence, any more than they can stop it taking place.

America, again, has suffered serious losses from insect infestations, and these have been experienced in the past as a direct outcome of hopeless mismanagement of the forests and wanton destruction by fire and axe.

But, as we have seen, well-ordered forests are equally liable to such invasions. Wherever there is a proper conservancy, and the nearer this conservancy approaches to a maximum of efficiency and intensity of management, the danger of insect invasion is inevitably enhanced.

An insect attack may commence after a bad fire on an area, or as a result of severe snow-break, or windfalls after severe storms.

A storm in the Vosges Mountains in 1902 blew down over one and a quarter million cubic metres of coniferous trees in a few hours. A severe bark-beetle attack commenced shortly afterwards, the first lot of beetles being reared in the windfalls. As soon as the windfalls were too dry or had been removed, the beetles went to the green standing trees (silver fir and spruce) in the neighbouring woods, and 14,603 trees had to be cut out and barked before the attack was stamped out; thus upsetting the working plan.

And it is not only in coniferous forests that the danger is to be feared, although the trees in these forests do not so readily recover from insect attack as is the case with broad-leaved species.

India has already had some first experiences of the power of the insect over its tree-host.

The attack of bark beetles (*Polygraphus* and *Phloeosinus*) experienced in the *Pinus gerardiana* forests in North Zhob, Baluchistan, between 1903 and 1906, resulted in a heavy loss of valuable trees, and had it not been taken in time might well have resulted in the disappearance of the forest altogether (fig. 21 and p. 510).

The Quetta borer (*Æolesthes*, p. 307), attack practically destroyed the major portion of the beautiful avenues of Quetta between 1900 and 1905, cost a considerable sum of money to get rid of, and an additional expenditure in replanting.

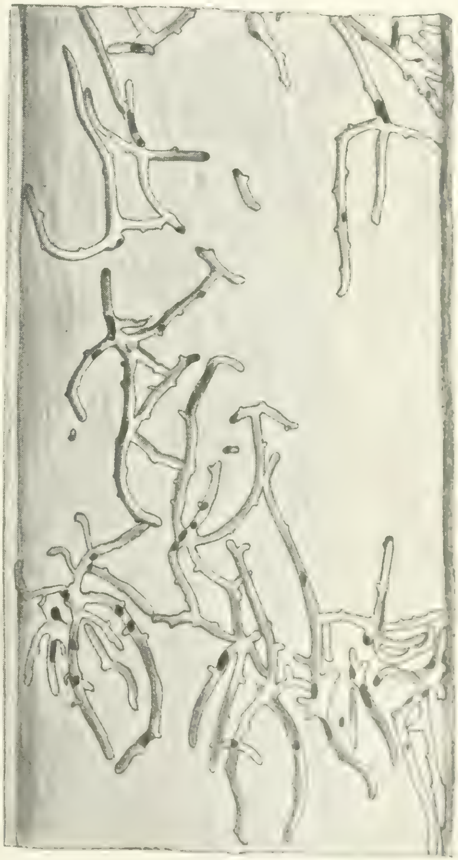


FIG. 22.—Egg-galleries of *Phloeosinus zhobi*, Steb., in *Pinus gerardiana* bark from North Zhob.

Bark-borers (*Scolytus* and *Tomicus*) made their appearance in the Bashahr State in 1900, and but for the prompt steps taken by Mr. B. Ribbentrop, C.I.E., at the time Inspector-General of Forests, and Mr. Minniken, who was in charge of the division, a considerable number of deodar and blue-pine trees would have been killed.

In the Simla Catchment Area a bark-beetle attack suddenly made its appearance early in 1908, and but for the action taken by the Divisional Officer, Mr. V. Munro, and his assistant, Pandit Gokal Dass, Extra-Assistant Conservator of Forests, would have undoubtedly developed into a dangerous

attack under which many trees would have been lost and the water supply have been to some extent endangered.

In the Bré forests in Chamba State numbers of trees were killed out on an important Catchment Area between 1906 and 1908, without the true source of danger being understood. I inspected many of these trees in 1909, and they had all been killed by bark-borers.

Deodar sowings in the nursery and out in the forest have succumbed to attacks of insects on a larger scale than has been recognized in the past, owing chiefly to the life histories of the insects concerned not having been known or understood. And the same applies to the loss of young *Pinus longifolia* plants in plantations in the Naini Tal Division and in the district forests under the attacks of the cryptorhynchid weevil (p. 428).

Heavy crops of seed of both coniferous and broad-leaved trees are almost entirely lost under the attacks of grubs of weevils, Scolytidae, and the caterpillars of small moths, thus seriously interfering with the regeneration of the forests.

Other instances might be quoted, but enough has been said to endorse the contention that the Indian forests are as liable to serious infestation from insects as are those of other countries, where an efficient Forest Department is engaged in improving the forest areas entrusted to its charge.

2. Aids to Insect Increase and Depredation.

There are various ways in which unpremeditated assistance is given to an insect, enabling it to increase in a forest in such numbers as finally to become a danger to the very existence of the trees themselves.

(1) **Pure Woods.**—The first of such causes is to be looked for in the creation of pure forests as against mixed ones. The bulk of the natural forests in the country are mixed ones in which one or more predominant species occur in company with a variety of, at present, less abundant or less important ones. The danger from insect invasion in this class of forests is much less than in the case of pure forests—i.e., forests consisting of one species of tree only. In these latter the insect, finding dense contiguous masses of its food plant available, may, given favourable climatic conditions, increase in such numbers as seriously to threaten the life of the forest as a whole. As an instance, a note of warning has been already struck in the case of forests of pure deodar in the Himalaya. The tree suffers from the attacks of several dangerous scolytid pests (*Scolytus*), as also from a buprestid and a longicorn (*Sphenoptera* and *Trinophyllum*). Already on several occasions trees have been found killed by these pests at a centre or at more than one centre in the deodar areas. Instances are not wanting to show that *Pinus longifolia* in dense pure forests is likely to suffer seriously from the attacks of the weevil *Cryptorhynchus* (fig. 23), from those of the longicorn *Nothorrhina*,

and two bark-boring beetles. In fact, the formation of pure woods in the Western Himalaya is, from the point of view of the great danger to which they are liable from insect attacks, to be deprecated. Again, the pure casuarina plantations of the east coast of Madras have suffered to some extent from the attacks of several insect pests, amongst the worst being those of the larva of the moth *Arbela tetraonis*.

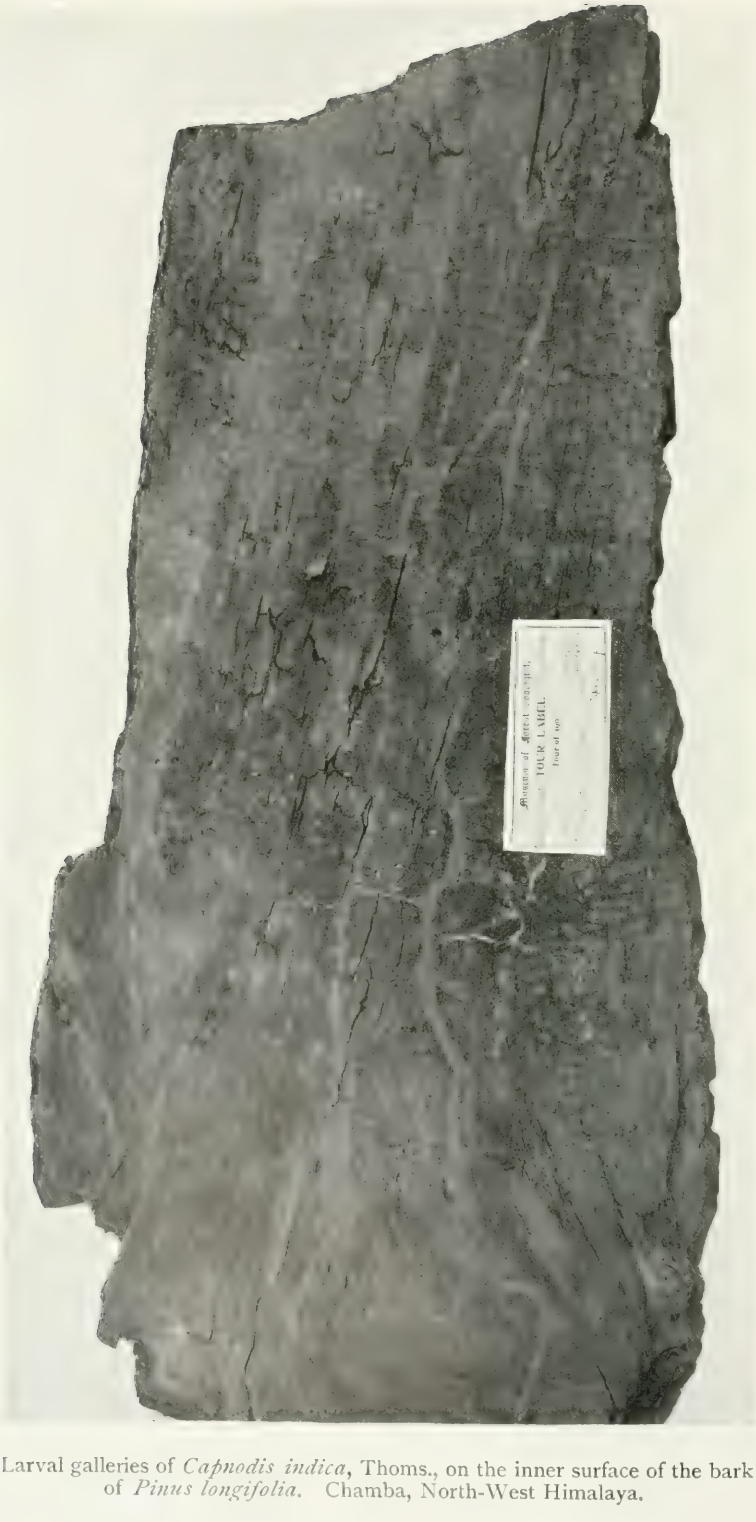
(2) **Mixed Woods.**—It is perhaps too early yet to discuss the question of the formation of mixed woods in India. Natural mixtures predominate throughout the country, and our knowledge of the insect pests of the trees is as yet too imperfect to enable definite statements to be made save in one or two cases. For instance, there is a scolytid beetle (*Polygraphus*) which attacks young blue pine. When the trees are too few in number to provide sufficient food for it, it will attack the deodar. Thus a mixture of a few blue pine amongst deodar is bad, since it exposes the deodar to attack from an insect which does not ordinarily infest it. I have seen two instances of this nature. The bark-beetle attack in the Simla Catchment Area of 1908 was aided in this manner. The area contains few blue

FIG. 23.—Portion of a young *Pinus longifolia* pole, showing the larval galleries of *Cryptorhynchus brandisi*, Steb., in the bast layer and outer sapwood. Near the top a larva is shown *in situ* in a gallery; an exit-hole of a weevil is seen in the bark at the bottom. Kumaun, N.W. Himalaya.

pine, and these merely served as death traps for the deodar. At Pajidhar in Jaunsar I saw a small plantation of young deodar entirely killed by this overflow of the *Polygraphus* from the already fully occupied blue pine. In the same way if the casuarina of the East Coast plantations is mixed with another species of tree to minimize the attacks of the *Arbela* caterpillar, care must be taken that a species is chosen which is not itself attacked by the caterpillar. For Mr. C. E. C. Fischer has shown that the larva feeds on the bark of a number of trees in addition to that of the casuarina.

(3) **Felling Operations.**—Properly regulated forest management ordains that the forest shall be kept free of all dying trees, dead material, tops and windfalls, etc. In the large areas which fall to the charge of the executive officer in India this ideal is not at present a possibility. Something more might, however, be attempted than is at present usually the case. The annual felling operations as undertaken throughout the country are a direct source of assistance to the insect pests of the forest. The difficulty in dealing with the tops, an enormous mass of branch wood, is at present in many instances an insuperable one over large areas where the management is on the selection system. The same difficulty does not, however, apply to the boles of the felled trees, which often lie in the forest from two to three months after felling before being finally cut up and removed. In these boles thus left unbarked incredible numbers of bark-boring beetles are bred. To quote a few instances. In Jaunsar I calculated in 1902 that the trunk of a large felled deodar 90 ft. in length from base of butt to the first branch (diameter, 3 ft. at base and 10 in. at top) gave rise to 54,000 beetles, allowing for casualties.

Again, whilst in the Goalpara forests with Mr. Perrée it was proved beyond question that the larvae of the longicorn *Hoplocerambyx spinicornis*, which lays its eggs in crevices of the bark of newly felled or dying standing sál-trees, get down into the sapwood of the bole within a week of hatching out, and that barking subsequently to this will not save the timber of that bole from being riddled and ruined by the large tunnels of this pest. In this case not only does the felled tree breed up future beetles, but at the same time the timber itself is ruined. In a perhaps lesser degree this is true in the sál areas of the United Provinces Terai and Central Provinces. The same tree if left unbarked after felling breeds out thousands of the bark beetles of the genus *Sphaerotrypes*, a species of which infests the sál of the United Provinces Terai, the Central Provinces, and Assam. In fact, there is no tree in India subject to the attacks of bark beetles which if felled and left unbarked in the forest for a couple of months but gives a home to thousands of maturing beetles which on leaving it search for other similar felled trees or standing sickly ones in which to oviposit. For it must be borne in mind that these bark beetles pass through from three to five generations or life-cycles in the year. Consequently when the felling



Larval galleries of *Capnodis indica*, Thoms., on the inner surface of the bark of *Pinus longifolia*. Chamba, North-West Himalaya.

season closes at the end of March in the plains the beetles bred out of the felled trees must seek standing diseased trees in the forest or windfalls in which to oviposit, and failing such must infest green trees; for fresh living bast and sapwood is a necessity for their larvae, which can neither live nor find sustenance save in sappy fresh bast and sapwood.

The point of the argument is, then, that though at present the number of beetles breeding in the tops of felled trees cannot be prevented, in the plains at any rate, it would be advisable to insert a clause in the felling contractor's agreement making it imperative that the trees he fells should be at once barked. Such a clause would do a great deal towards keeping down some of the most serious of the pests of the trees.

In the coniferous forests, where the danger from bark beetles is far greater than in the broad-leaved areas, the thicker branches of the tops should also be barked, and wherever possible the tops should be burnt or at least have the outer bark carbonized so as to render it unpalatable to bark beetles.

(4) **Fires.**—The danger to be feared from fire running through a forest is due to the fact that a number of trees, the number depending upon the intensity of the fire, are liable to become weakened in health and thus to lose vitality. In this state they afford suitable material for the oviposition purposes of bast- and wood-feeding beetles, and, under the attacks of these, trees which might otherwise have recovered in time, finally succumb and die. The danger from fires overrunning a forest, so far as subsequent insect attack goes, is greater in coniferous forests than in broad-leaved ones.

Present observations would seem to indicate that fires in deodar, blue-pine, or spruce forests in the Western Himalaya are, if the trees are at all scorched, almost invariably followed by an attack of the deodar *Scolytus* beetles, and the spruce and blue-pine *Tomicus* and *Polygraphus*. In the *Pinus longifolia* areas the fires which sweep over considerable tracts of the Kumaun district forests have led to the trees being seriously attacked in parts by the *Cryptorhynchus* weevil, the *Capnodis* and *Anthaxia* buprestids, the *Nothorrhina* longicorn, and the *Tomicus* and *Polygraphus* bark beetles.

After a fire has occurred in a coniferous area in the Himalaya the closest scrutiny should be kept on the trees during the following two years, and those seen to be infested with bark beetles should be cut out, cut up, and the bark burnt.

Similarly, when a severe fire has run through an area of young sal-tree growth, trees whose vitality has been much lowered will be infested by the *Sphaerotrypes* bark beetles.

The timber of trees dying or newly killed by fire is at once infested by *Sinoxylon* and other wood-borers; sissu, sál, *Terminalia*, *Pterocarpus*, etc., being liable to such attack.

(5) **Natural Phenomena—Windfalls, Snow-break, Frost, etc.**—At present the danger from excessive windfalls taking place is only likely to occur either in plantations or in the Himalayan coniferous areas. Damage resulting from devastating cyclones, however, such as the Chittagong cyclone of October 1897, which swept a clear strip several miles in width through the forests of the Chittagong Hill Tracts, the whole of the forest being laid low, is almost certain to be followed by the increase of one or more bad forest pests. One of the results of the above-mentioned cyclone was that the *muli* bamboo (*Melocanna bambusioides*) sprang up in thousands on the area cleared of trees by the cyclone, and this sudden increase in its food-plant was followed by the appearance of enormous numbers of the *Cyrtotrachelus longipes* weevil, which oviposits on this bamboo (p. 440). It is chiefly, however, in coniferous forests that the danger from windfalls, as also from snow-break, is greatest and most to be feared. Thrown deodar, blue pine, spruce, and long-leaved pine are all immediately attacked by scolytid bark-boring pests or by buprestid and longicorn ones within a week or two of their fall, unless this takes place in the winter. In the latter event the first generation of beetles to appear in the spring will oviposit in the fallen trees. The deodar buprestid *Sphenoptera* and the *Scolytus* beetles have been found in large numbers in snow-broken deodar on many occasions.

The danger from frost is probably greatest in the plains, and especially when abnormally severe frosts are experienced in areas which are usually either entirely free from frost or are only subject to light ones. Severe frosts in such localities leave a large number of trees in a more or less temporarily moribund condition. The trees will not die if they are given time to recover and are not subject to any further strain. Such trees are, however, in the condition in which they are most easily assailable by their bark- and wood-boring enemies, and these kill off many a tree which but for their attacks would have recovered itself in the course of two or three years. The great frosts of February 1905 are a case in point. Great damage was done to the forests over a large tract of country, of which records are to be found in the *Indian Forester*.* I had an opportunity of examining a considerable area of the sál forests of the United Provinces Terai and Siwaliks, including Philibhit, also some of the sál areas in the Central Provinces, and my observations tabulated showed that in many places trees weakened by the frosts had been subsequently killed by the bark-borer *Sphaerotrypes* and the longicorns *Æolesthes* and *Hoplocerambyx*. I made some careful notes in the Siwaliks and United Provinces Terai in 1906, 1907, and 1908 on the after-results of the frosts of 1905. I found that numbers of the younger sál-trees whose upper half had been killed by the frost were attacked below by *Sphaerotrypes siwalikensis*, and that both this beetle and the *Æolesthes* appeared in many of the older, thicker trees whose vitality had been greatly

* *Indian Forester*, vol. xxxi, pp. 337, 435, 438, 496, 569; xxxii, pp. 24, 342.

impaired by the frost. The forests were full of stag-headed trees or poles with their upper parts dead, and the fact that the presence of the insects was not more apparent was simply due to the large number of weakly and dying trees for them to breed in.

The after-effects of severe frosts in young pole forests will need very careful watching in future, since the crops on the ground are, with better and closer management, yearly becoming more dense, and thus more susceptible to insect attacks.

3. Methods of Ascertaining the Presence of Insects in the Forests and of Preventing Damage.

The abundance of particular insect pests in an area of forest may be ascertained in various ways, depending to a great extent on the life history of the individual pest. For instance, defoliating caterpillars when in abundance soon make their presence evident by stripping the leaves from the trees. A knowledge of the full life history and appearance of these insects will, however, enable the forester to be forearmed against this form of attack, for before the larvae appear in swarms sufficient to completely defoliate the trees, the moths must have previously been swarming on the wing in the forest, laying the eggs from which the larvae hatched out. Therefore, if you have the knowledge which will enable you to recognize the moth you will have been forearmed against a probable serious attack of the caterpillars. Reports have often been forwarded to me that in such a month small moths have been seen in great numbers flying about the trees. A few weeks later these trees have been stripped bare of all foliage. The life histories of the insects being unknown, however, the knowledge which would have connected the first appearance of the moths with a probable subsequent severe defoliating attack was absent.

The seed of trees is also subject to attack by caterpillars, the sál by the larvae of *Coccotrypes* sp. (p. 543) and the caterpillars of species of *Conogethes*, *Laspeyresia*, *Cacoecia*, etc., and the deodar, silver fir, spruce, and blue pine by caterpillars of the moths *Phycita abietella* and *Eucophera cedrella*. If the small moths of these species are very abundant in the sál forests just before the rains, it may be taken as almost certain that the seed crop the following year will be severely attacked, and will be practically a failure. Similarly, in the case of the conifers, if the moths of the two species above mentioned are numerous in the forests in September and October, the probabilities are that the cones of the following season will be riddled by caterpillars, and the production of seed be very scanty or nil. These inferences are not of course certainties, since a long, cold, wet spring in either case may result in many of the young caterpillars hatching out of the eggs laid by the moths on the twigs of the trees being killed before they have got into the interior of the seed or down into the cone.

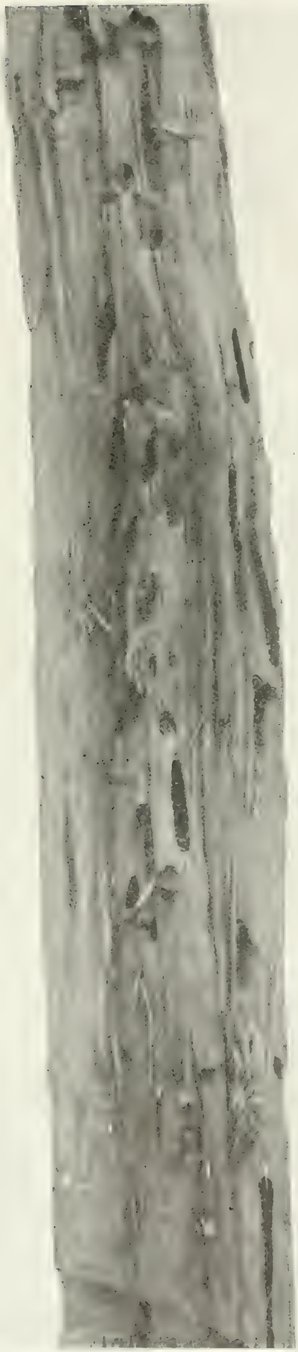
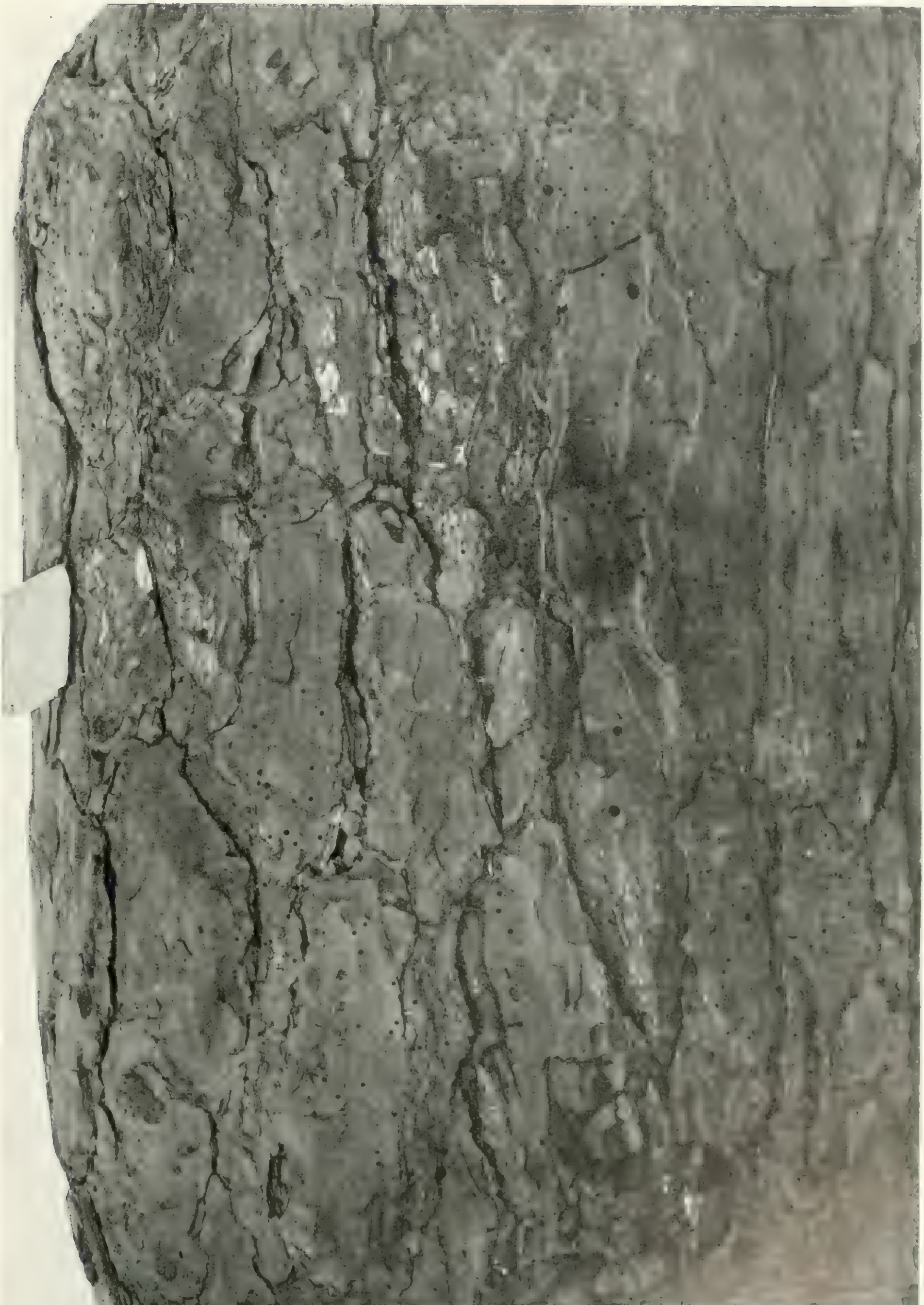


FIG. 24.—Interior of section of a stem, showing pupating-chambers of a longicorn beetle.

It is not possible, however, to obtain a previous warning in all cases. For instance, the *Monophlebus* sál scale, which infests the sál in the Siwaliks and United Provinces sál forests, generally affords, so far as is at present known, no such previous evidence of a bad attack—such attacks, e.g., as were experienced between 1898 and 1902 in this region.

The forester is on safer ground when he wishes to ascertain the abundance in the forest of the bark- and wood-boring pests of his trees. It is always possible for him to keep himself posted with practical certainty on this point. If you walk through a wood in Germany or France you will find felled green trees at intervals lying to one side of the road or path. These trees have been felled with the express purpose of enabling the forest officer to keep himself informed as to the presence of and abundance of the bark-boring and timber-boring insect pests which infest the particular species of tree of which his forest is composed. By cutting off a square of bark at the period at which he knows the insects will be on the wing in the forest, he will be able at once to ascertain their abundance. For both bark-borers and wood-borers will resort to these freshly felled trees to oviposit instead of searching for sickly trees or fresh windfalls in the forest itself. He will, therefore, find these insects at work boring through the bark to oviposit in the bast, or tunnelling down into the timber to lay their eggs there. If at any period he finds these trees full of



Piece of spruce bark showing the entrance-holes of *Tomicus* and *Polygraphus* bark-borers on the outside of the tree. The large holes are those of the saw-fly *Sirex imperialis*. North West Himalaya.

insects he will have early information that an attack on a severe scale is imminent, and will be able to take his measures in time to combat it. And to be ready for such an attack means the possibility of stamping it out before it assumes proportions against which nothing short of felling on a wholesale scale will make headway. Trees felled in this manner partake of the nature of what are called "trap trees," the use of which will be described later on.

With regard to the prevention of damage from insects when we have ascertained that an attack is imminent, the measures that can be put in force depend to a great extent on the staff available. In many parts of India the staff is still so inadequate in proportion to the large areas to be dealt with that proposals for taking action to *prevent* attacks are difficult to suggest.

The judicious use of fire on an area where it is known that an insect is passing through its pupal stage amongst the dead leaves or humus or in the first inch of the soil on the forest floor will be dealt with in the next section. Much might, I think, be done in this manner, provided the proper amount of attention can be given to the work. As we shall see, a number of pests are to be found in this position; many caterpillars pupate here; the sál *Monophlebus* lays the bulk of its eggs on the ground, and so on.

In the case of the bark-boring beetle and caterpillar pests the prevention of attacks is easier. With the caterpillars the first beginnings of an attack are usually easily seen on the bark, and can be dealt with if the life history of the insect is understood. The first beginnings were noted with the commencement of the bark-eating *Arbela* attack in the casuarina plantations in Madras in 1902–3. Had the life history been known and the trees affected been cut out and the caterpillars killed, what proved eventually a disastrous infestation in some plantations might have been nipped in the bud.

Bark-beetle attacks usually commence at a centre or several centres, and spread outwards. If these centres are marked down and the infested trees promptly cut out and burnt the attack will be stopped in its initial stages and the rest of the forest saved. The "trap trees," to which I have already alluded, will give the necessary warning that such an attack is imminent.

4. Methods of Combating Attacks in Progress.

The methods to be put in force to counteract and stamp out attacks of pests which have assumed serious dimensions vary with the life histories and consequent method of attack of the insects concerned.

The methods required to combat the attacks in trees either standing or lying felled in the forest differ from those which must be put in force to stamp out attacks of wood-borers pure and simple in wood-stacks or piles of bamboo, whether these are standing on roads in the forest or in depots.

Again, a large number of insects pupate amongst the dead leaves on the forest floor, or in the humus layer, or in the first inch of the soil. Many root-feeding grubs, of which there are a number of pests, may also be found here. Or the insects lay their eggs here. Methods of destroying these in the forest differ from the ways in which we can attack them in the nursery and plantation.

(1) **Bark- and Wood-boring Beetle Pests in the Forest.**—I have already alluded to the fact that serious attacks of bark-boring beetles, Scolytidae, and those of Buprestidae, Cerambycidae, and Curculionidae have already been experienced in parts of India, and practical measures have been put in force to combat them. The following proposals for combating attacks of these pests are based on the practical experience gained in actually carrying out such work in India, and prove that this work is not only possible, but amply repays being undertaken.

The methods to be briefly described here presuppose a knowledge of the life histories of the pests which have to be dealt with. The measures apply equally to infestations in hill and plains forests.

Assuming that a serious attack of bark-boring beetles is taking place in the forest, this may be accompanied by either a buprestid or a cerambycid one, or both. In some cases a weevil, such as the *Cryptorhynchus* of the long-leaved pine tree, may also be present. The larvae of these insects feed, for a time at least, in the bast layer. Accompanying these bast feeders you will probably find at least one species of wood-boring scolytid or a bostrychid. These will bore straight into the wood and oviposit there.

The beetles may be attacking the trees in any one or all of the following conditions:—

(*a*) Newly felled or fallen green trees (wind- or snow-breaks).

(*b*) Standing sickly trees.

(*c*) Standing green trees in the neighbourhood of a "centre" of infection.

Accordingly the first step to be taken is to mark down all infested trees, whether felled or fallen, standing sickly, or standing healthy trees.

(a) *Newly Felled or Fallen Trees.*—The first of these are known and can be easily marked down. The second should be searched for and marked down. This will involve going over the whole area carefully.

(b) *Standing Sickly Trees.*—The whole area must be gone over and all infected trees found should be noted and marked with a tar ring. It is not to be expected that the whole of these trees will have been found in time to catch the next generation of the beetle to issue after the attack was first discovered. If this generation is not caught it should be possible to mark all the trees down in time to catch the larvae of the second or third generation.

In the case of (*a*) and (*b*) the stems or trees will be left in the forest until they are known to be full of grubs according to the data given under

the life history. (*b*) should then be felled, and (*a*) and (*b*) barked and the bark turned up so as to expose it to the rays of the sun. This will be strong enough to kill off the larvae. All saplings or branches which are too thin to be barked should be burnt. If, however, (*b*) are not badly infested with the beetle they should be left standing to serve as "trap" trees for succeeding generations.

(c) *Standing Green Infested Trees.*—It will be found that newly attacked green trees are much more difficult to deal with, as their removal must depend entirely on the degree to which they are attacked and on their nearness or otherwise to "centres" of infection. It will also be found very difficult to discover them until they are commencing to fade, when the bright yellow needles of the conifers or the drying shrivelled leaves of the broad-leaved species attract attention to them. It may prove advisable to leave those discovered, when but slightly attacked, standing over one, two, or even three generations of the insect, since there is a likelihood of their serving as an attraction to further beetles to lay their eggs in. They thus serve as "traps," and if used as such properly they may attract a large number of beetles which would otherwise oviposit elsewhere in uninfested trees. In all cases where such trees are not very seriously attacked they should not be felled before the larvae of the *second* generation of the beetle after finding them are reaching full growth. They will thus serve the purpose throughout the area of "trap" trees.

"*Trap*" *Trees.*—In order to ascertain the extent and intensity of an attack suitable green trees should be chosen here and there in the forest, preferably along a road or footpath, and felled. These trees should be felled just before the periods at which the beetles are to be expected on the wing in the forest. It will be found that the beetles will resort to these felled trees to oviposit, and the trees will thus serve as "traps." As soon as they are full of fully grown larvae they should be barked and the bark exposed to the sun or burnt, as may be deemed most advisable. If a "trap" tree is not seriously infested by the generation of the beetles issuing soon after it has been felled it may be left for a following one. The trees should be so felled as to lie in a position sheltered from the sun during the hottest portion of the day. They must not, however, be felled in dense shade, as the beetles will not resort to such trees to oviposit. In choosing these trees it should be borne in mind that they must be healthy and full of sap. It will be useless felling nearly dead trees for such a purpose, as they would rapidly dry and would not be sought out by the beetle. The beetles require fresh sappy cambium to lay their eggs in.

The periods at which the "trap" trees and the sickly standing trees should be felled and the bark stripped off and burnt will depend upon the life histories of the pests you are combating. The time at which the trees should be felled is at the period when they are full of completely developed grubs and newly changed pupae. The latter must not be allowed to mature into beetles, or the earliest maturing ones will either escape from the tree before you fell, or fall out of their pupal chambers when the

bark is stripped off, and fly off and infest fresh trees in the forest. The periods will, of course, vary with elevation, aspect, etc., and be a little later in wet cold seasons; but the time can always be accurately determined by stripping off a piece of bark and examining the larval galleries on the inside to ascertain whether they have nearly reached their normal length. If they have, the full-grown larvae or pupae will be found at the end or in the sapwood beneath, and the time has come to bark the trees.

In the case of the bark-boring Scolytidae, stripping off the bark and burning it will be sufficient to destroy the insects, as they mostly pupate in the bast or partly in the bast and partly in the sapwood. The fact of taking off the bark and exposing them to the heat of the sun or cold at night is sufficient to kill the larvae and pupae, although it will not kill immature beetles.

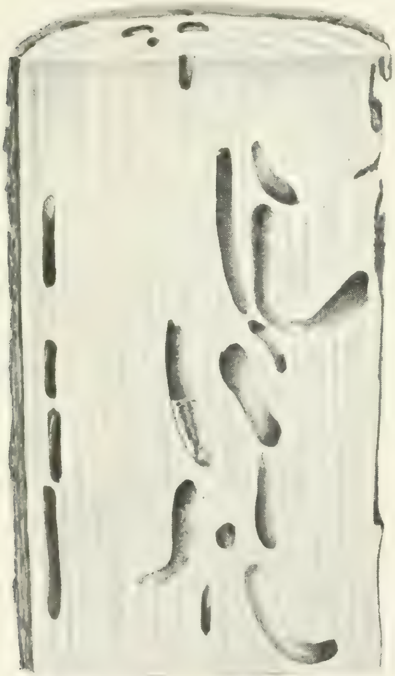


FIG. 25. Pupal chambers of *Hoplocerambyx spinicornis* in heart-wood of sál-tree (much reduced).

The buprestids and cerambycids pupate in the sapwood, and the wood-boring Scolytidae, etc., oviposit here or right down in the heart-wood. To get rid of these the trees must be logged and the logs burnt.

(2) **Wood-borers in Timber Stacks, Fuel Stacks, and Bamboo Piles in Depots.** Wood stacked in depots or out on the forest roads and rides, if left for any time, is subject to the attacks of various boring beetles, of which species of Bostrychidae are amongst the worst in India. Some of the Scolytidae also do damage in this way, and a few Cerambycidae. As instances of damage of this nature, the genera *Sinoxylon* and *Dinoderus* in the first family, *Xyleborus* in the second, and *Stromatium* amongst the Cerambycidae, may be quoted. The females of all these insects tunnel down into wood, usually when the first sap has dried out of it, to lay their eggs. On hatching out the grubs feed in the wood, reducing its structure to powder. Or in the case of some Scolytidae the damage is solely due to the wood becoming excessively "shot-holed" from the number of the beetles boring in to oviposit, and thus ruined for timber purposes.

Finally, in the case of some of the cerambycids who lay their eggs on green trees, the grubs may have tunnelled into the heart of the timber to pupate, and be there or engaged in this operation after the timber has left the forest for the depot (*Æolesthes*, *Hoplocerambyx*).

FIG. 26.—Three lengths of a young deodar sapling infested by *Scolytus major*, Steb., and *S. minor*, Steb. The middle one shows the entrance-holes of female beetles on the bark ; the left-hand one the long vertical zigzag egg-galleries on the sapwood ; and the right the whole sapwood scored by the larval galleries, the shot-holes being the pupating chambers of the grubs. It forms a typical example of the capacity exhibited by this bark beetle for the destruction of young sapling and pole growth. N. W. Himalaya.

In all cases the result is the same. The value of the timber, firewood, or bamboo is greatly reduced, or the material is so riddled as to be useless for all purposes save that of inferior firewood. Considerable loss has occurred in various wood depots throughout the country, and especially at the fuel depot of the Changa Manga plantations, in days past. Fuel stacks seen here consisted principally of masses of wood powder owing to the severe infestations by the two beetles *Sinoxylon crassum* and *S. anale* (fig. 27).

In cases of bad infestations of this nature the only chance left of thoroughly clearing the depot is to burn completely the whole of the infected material, and this must be done at the period when the insects are in their larval and pupal stages in the wood, and *not* at the periods when the insect is on the wing in the depot. In the former case you will get rid of the pest in one operation, or so reduce its numbers that it will not assume the importance of a pest for some time to come.

(3) **Insects which Oviposit or Pupate amongst Dead Leaves on the Forest Floor or in the Humus or First Inch of the Soil.**—A number of insects are now known which pupate on or a little way beneath the upper layers of the forest floor, amongst the dead leaves, in the humus, or in the first inch of the soil. To mention a few: The teak defoliators *Hyblæa puera* and *Pyrausta machaeralis* act in this way, so does one at least of the conifer cone destroyers (*Euzophera* and *Phycita*). The deodar defoliator (*Geometrina?* sp.) acts in the same manner, as also the *Boarmia* defoliator of the sál-tree in the United Provinces Terai. Again, almost all the seeds of forest trees at present known to be infested by insects fall to the ground from the trees when the grub has nearly or quite reached full size. The grub then either leaves the seed and burrows into the humus layer, or pupates within the seed. The latter, however, is now on the forest floor! Examples of such are:—The sál-seed destroyers (*Conogethes*, *Laspeyresia*, etc.); also the *Alcides* weevil of the walnut, the *Callirhytis* fly of the kharshu oak (*Q. semicarpifolia*), and the *Calandra* weevil of the ban oak (*Q. incana*).

The weevil sissu-leaf defoliators (*Apoderus*) also pupate amongst dead leaves on the soil, the little leaf-roll in which the larva feeds falling to the ground.

Again, some insects oviposit amongst the dead leaves on the ground or amongst stones, pieces of fallen wood, etc., on the forest floor. Of such is the *Monophlebus* scale of the sál-tree. This insect lays over six hundred eggs in a loose silken sack on the ground amongst leaves or beneath stones, pieces of wood, etc., and lays them at the very period (April and May) when the sál-defoliating *Boarmia* is pupating in the soil. Thus we have two serious pests in a quiescent stage in a place where they can be got at at the same time. And there is another class of pest in these forests, several species of melolonthid grubs (*Lachnosterna*, *Heteroplia*, p. 77), which is to be found feeding on the roots of the sál-tree or in the pupal stage within the first inch of the soil layer at this period.

My suggestion for destroying these pests is to attack them when in their quiescent stages, and to attack them with fire. I would run a leaf fire through the infested forest and take care that it was kept a leaf fire, cutting down areas of long grass or fire-tracing them.

In the days before the Forest Department, and for some considerable period afterwards, there was no fire protection. The annual fires did a great deal to keep the insect pests in check. These pests now breed unhindered from year to year, and the only possible outcome must be severe visitations. Instances of such may be quoted. Deodar areas in parts of the Western Himalaya are defoliated year after year. Areas of sál are completely defoliated or the tree is infested for several years together by a scale like the *Monophlebus*, and nothing is done to endeavour to diminish the pests or deal a heavy blow at them when they are really numerous.

That fire is effective two instances would seem to prove. With the permission of the Conservator (Mr. B. B. Osmaston), Mr. R. C. Milward had a small area in the Garhwal forests, in which the sál *Boarmia* was pupating, fired for me in May 1908, and sent me the materials in the way of larvae, pupae, etc., collected after the firing. I examined the mass carefully, and was of opinion that the firing had resulted in practically killing off the majority of the pupating caterpillars—and they were in thousands in the soil, or on their way there from the trees overhead, at the time of my visit. Those which appeared still to have some life in them and the pupae came to nothing, and not a single moth issued. A week or two later in that year I was at Horai in the Kumaun Division. A fire of some severity had overrun three compartments just previous to my arrival. I made a careful examination in the burnt area for pupating caterpillars, and also ascertained the result of the fire on the cockchafer grubs. I found no instance of a living grub or larva in the soil, though my men and myself took numbers of dead and often charred ones. The fire had not killed nearly mature cockchafer beetles, which proves how necessary it will be to fire, if fire is made use of, when the pest is in its larval or pupal stages. These stages will be known from its life history.

(4) **Root-feeding Insects.**—I have already dealt with root-feeding grubs in the forest. In the nursery and in patches of sowings in the forest and in plantations there are one or more methods of destroying them which may be tried. In the young conifer nurseries and sown areas in the Himalaya (deodar and cryptomeria), in the babul plantations in the United Provinces and Berar, in those of poplar in Baluchistan, and in casuarina plantations in Madras, trouble has been experienced from the attacks of both internal and external root-feeding insects. In the former class comes the *Coelosterna* longicorn in babul (fig. 8) and the *Trochilium* caterpillar in poplar, whilst in the latter are the Melolonthinae (see pp. 77–81), the Elateridae (p. 230), and the *Agrotis* cutworm. Crickets also occasion harm, *Brachytrupes achatinus* having destroyed *Ficus elastica* seedlings in nurseries. These latter insects

live at the bottom of holes in the nursery beds or somewhere closely adjacent.

To combat the attacks of the internal root-feeders dig out and burn *in toto* all young plants which show signs of flagging. Collect the mature forms of the insect when it appears on the wing.

For the external root-feeders the methods advocated are the following: Before making sowings in patches out in the forest, it is advisable to turn up the soil for a couple of feet in selected spots to ascertain whether these root-feeding larvae are abundant on the area or not. If they are so, it is almost useless endeavouring to restock the area by means of sowings.

In nurseries, bundles of some succulent crop plant poisoned with Paris-green water or dilute kerosene may be placed on the seed-beds before the young plants come up. Caterpillars such as the *Agrotis* will resort to these and be killed. Birds should be attracted to the nursery so far as possible by affording them nesting facilities. If the nursery beds are infested with root-feeding grubs, a good plan is to flood them. This will bring the grubs to the surface, when they will be devoured by the birds. Dusting the plants in the evening with a mixture of quicklime and ashes is also effective. If you find the nursery pitted with holes, these should be dug up and the larvae or crickets, etc., found be killed. Finally watering the beds with a solution of copper-sulphate is sometimes productive of good.

In plantations where the young seedlings are seen to be withering and dying off, employ women and boys to remove the soil round the roots. The grub or grubs will be found at the roots, and should be taken out and killed. Or, as in the nursery, if feasible, flood the plantation for several hours. Another method, which can be employed against the crickets, is to provide boys with a length of bamboo containing water and send them into the area with instructions to pour water down each hole they come to. This will bring up the cricket or crickets, for there may be two or more at the bottom of the hole, and these should be caught and killed. It is desirable when employing labour in this way to insist on the insects caught and killed being brought in, and it is often best to pay by results achieved.

5. Methods of Protecting Station and Cantonment and Valuable Orchard Trees.

It is often possible and desirable to incur a greater expenditure on the protection of the trees of the station or cantonment, or valuable orchard trees, than is justifiable in the forest or plantation. Forest Officers are often asked to suggest a possible treatment in cases where damage of this nature is taking place.

The avenue and trees of the station compound are all liable to insect attack, and more especially is this so in the drier parts of the country. The longicorn-borer attack in Quetta (*Æolesthes*, see p. 307) is an evidence of the state to which careful planting work can be reduced if the insects preying upon the trees are not known and watched.

The first protective step, which will greatly tend to diminish danger of this nature, is to plant avenues with several different species of trees alternating with one another. It is the pure avenues—i.e., avenues consisting all of one species—which are liable to suffer most seriously from insect damage.

I inspected a tun-tree avenue in Bengal some years ago. It was pure, and there was scarcely a tree worth maintaining on the ground, so badly had the crowns been attacked by the tun twig-borer (*Hypsipyla*). The

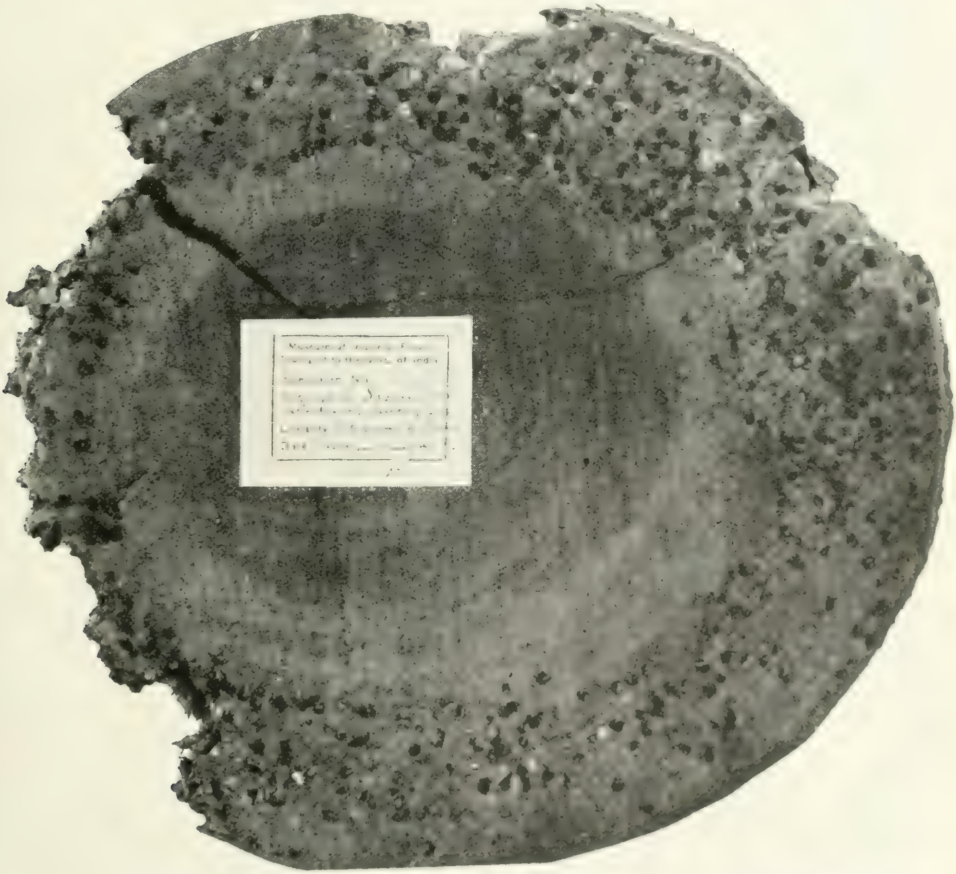


FIG. 27.—Section of stem of a *Dalbergia sissoo* tree, showing the sapwood riddled and destroyed by the wood-borers *Sinoxylon crassum*, Lesne, and *S. anale*. Changa Manga.

crowns were thin and straggly, and afforded little shade, besides being very unsightly, and the owner (the avenue was on a tea plantation) had the whole thing cut down and replanted. It is best, therefore, to avoid planting pure avenues; but if such are desired, choose a tree which is not liable to be attacked by some of the common insect pests.

Fruit trees are often used in this manner with a view to obtaining a yearly revenue from the fruit. These trees require watching just as they do

in the orchard, for they are liable to insect attack. Mango-trees are badly infested by several longicorns (*Batocera*, p. 367, *Plocæderus*, p. 295, etc.), and by a buprestid (*Belionota*, p. 217), these beetles killing off large branches or the whole tree, as was evidenced in a bad attack of these borers at Chicacole in Ganjam. Fig-trees suffer in Baluchistan from a longicorn borer (*Batocera*, p. 362). The small branches of the mango suffer from the attacks of a bostrychid (p. 129) and a scolytid (p. 542), and the whole crown from a *Monophlebus* scale insect. Loquat-trees suffer in their leaves, flowers, and fruit from the attacks of caterpillars. Palms of various kinds are infested throughout the country by the rhinoceros beetle (*Oryctes*, p. 87) and the palm weevil (*Rhynchophorus*, p. 444) and so on. These trees may be tended and treated for these attacks in various ways.

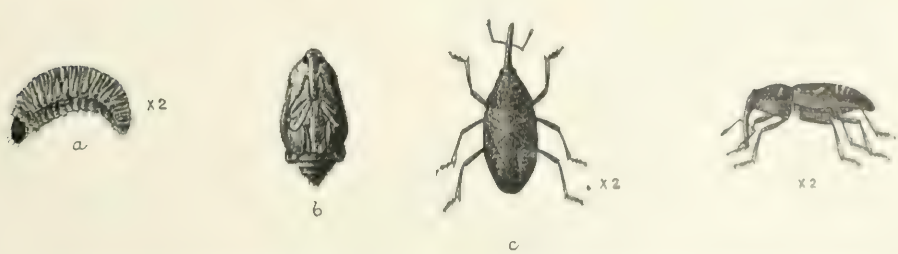
Really badly infected trees, infested by borers and large bast-feeding pests, must, if the insects are in the main trunk, be cut out and burnt *in toto*. If left they merely form centres from which other at present healthy trees will become infested. If only branches are attacked these should be cut off near the main trunk and burnt, and the pruned spot thickly coated with tar. Whenever a tree is pruned the place from which the branch has been taken should be thickly tarred. When small branches and twigs are seen to be drying and dying they are probably infested with a bostrychid or scolytid pest, or a small longicorn and buprestid borer. These branches should be collected and burnt. This will prevent the next generation issuing from the trees and infesting fresh ones. The case of bark-boring beetles in the main stems, as also that of the bast- and sapwood-feeding caterpillars, is more difficult. Often their presence may be detected either by shot-holes on the outside of the bark with sawdust below them, or by masses of resin or "tears" of resin dripping down the bark on the outside, or in the case of the caterpillars by outside galleries composed of silk and excreta corkscrewing round the trunk. In the latter case the grub may be found in the tunnel, though more often during the daytime it conceals itself beneath the bark in a cavity made in the bast and sapwood and only issues to feed on the outer soft bark at night-time. He can, however, be traced back to the opening leading to his shelter if the silken tunnel is pulled off the outer bark. A thick patch of tar placed over the opening and jammed into it may kill him. In the case of broad-leaved trees, such as the poplar, an outflow of sap from the hole will be seen on the bark (pl. vii).

Another plan is to paint the bark with a mixture of kerosene and tar and set fire to the area. This will kill all the insects in the bast and outer sapwood. Only the area affected will be burnt, and the burnt portion should then be thickly coated with tar, especially at the edges where it meets the unburnt bark. This mixture was tried by Captain H. S. James on the chilgoza-trees in the Zhob forests, which were infested with bark-boring beetles, after he had experimented with several other materials, and found to give excellent results. It would probably only be applicable to thin-barked trees.

A poplar-tree infested by the grubs of *Æolesthes sarta*, Solsk. The heavy outflow of sap caused by the attack is seen dripping down the bark. Quetta, 1905.

Finally, to prevent pests such as caterpillars moving from tree to tree up or down the trunk, bands composed of a thick greasy material or of a sticky material such as molasses should be painted on the tree, the band being at least eight to twelve inches deep. These bands can be utilized efficiently against another pest in the case of mango-trees. The *Monophlebus* scale insect which sucks the sap from the leaves and later from the twigs of the tree, often thereby spoiling the fruit crop, when intent on egg-laying crawls down the tree-trunk to oviposit in the soil below. It does not appear to oviposit on the trees. Therefore, if in a severe attack broad sticky bands are painted on the trunks about four to five feet above the ground, the insects will be caught on these as they crawl down the tree, and another bad infestation of the pest may be prevented the following year. Care must be taken to scrape down inequalities of the bark at the point where the bands are put on, otherwise deep crevices may not be properly coated with the stuff, and insects finding them will escape through the band to oviposit below.

Aphidae and Coccidae such as *Chermes*, *Lachnus*, *Coccus*, etc., occasionally prove serious pests to trees. In the case of valuable avenue, garden or park, and orchard trees, methods of treatment inapplicable in the forest are possible. For instance, in cases where the eggs are deposited in crevices on the bark of the main stem and large branches, it is often effective to brush them down with hard bristle brushes dipped into a paraffin emulsion, or to spray these parts with the mixture. A good emulsion consists of paraffin, 2 gallons; soft soap, $1\frac{1}{2}$ lb.; caustic soda (98 per cent.), 6 lb.; water, 28 gallons. Dissolve the soap in a gallon of boiling water, add the paraffin, and churn thoroughly till a cream-like mass is obtained. This thorough mixing is essential. Dissolve the caustic soda in 27 gallons of water and pour into the paraffin emulsion, and mix the whole intimately. The mixture should be used as soon as made. The emulsion should not be applied to the green parts of trees or to unripe wood, nor should it be allowed to get on to the skin of the operator.



Cryptorhynchus brandisi, Steb. *a*, larva; *b*, pupa; *c*, weevil from *Pinus khasya*. Shillong, Maymyo, Upper Burma.

CHAPTER V.

COLEOPTERA.

(*Beetles.*)

Brief Synopsis of Characters of the Order.

The Coleoptera or beetles are insects furnished with a biting mouth, the biting jaws being known as mandibles; the lower lip is divided medianly. The insects appear to be wingless, the back being covered by hard, horny, scale-like structures termed the elytra, which fit closely together down the centre. Beneath these elytra a pair of membranous wings are usually present. Beetles are readily distinguished from other insects owing to the fact that the whole of the insect is covered with a hard horny substance known as chitin, this enclosing the insect as it were in armour. The general shape is spherical, flat or otherwise, to long linear.

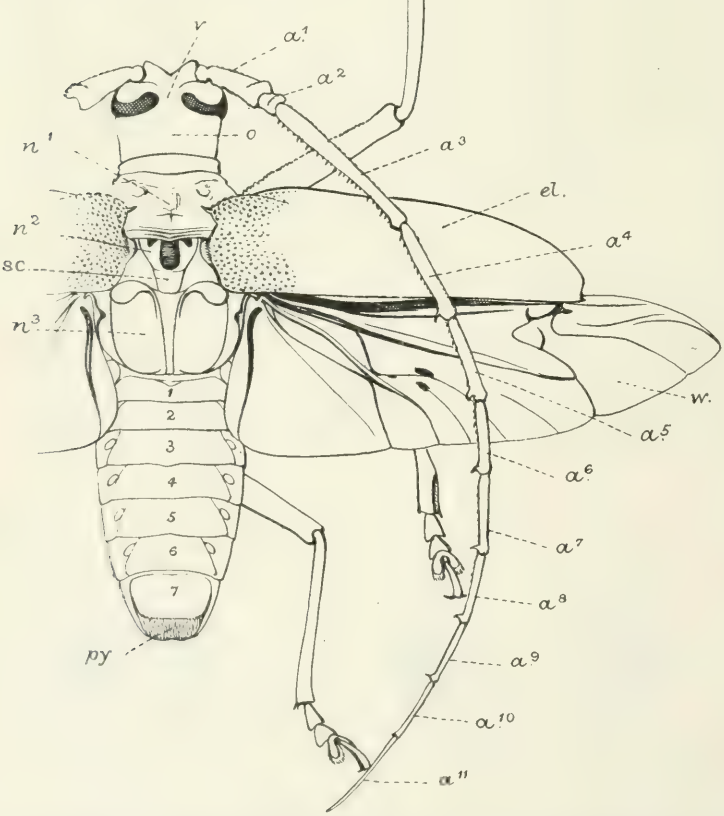


Fig. 28.—Longicorn beetle (*Batocera*). Dorsal view with wings outspread. *v*, vertex; *o*, occiput; a^1 to a^{11}, joints of antennae; $n^{1\ 2\ 3}$ prothorax, mesothorax, metathorax; *el*, elytron; *w*, wing; *sc*, scutellum; 1, 2 to 7, abdominal segments; *py*, pygidium.

On the head the mandibles are usually well developed; the eyes are compound, and often divided into two parts, or they may be reniform in shape; the antennae are eleven (or fewer) or twelve jointed, the joints varying in shape and length. At times, as in the Buprestidae, the faces of the joints may be set with poriferous pits. The antennae are of importance in the classification of the order, as are also the

various hard chitinous parts of the insect. Behind the head comes the prothorax, which is capable of a certain amount of movement of itself. It varies in shape—round, angular, square, trapezoidal, etc. The other parts of the thorax, the meso- and metathorax, are hidden beneath the elytra and are not visible from above. The mesothorax is small, the metathorax being very large in the winged forms of Coleoptera. In the figure the different parts of the thorax and the other simpler portions of the external surface are named. For full details on the subject the reader should consult a text-book on entomology. The elytra when closed cover nearly all the mesothorax and the whole of the metathorax, lower wings, and abdomen. The upper portion of the mesothorax may be visible in the shape of a triangular or square, etc., shaped piece known as the

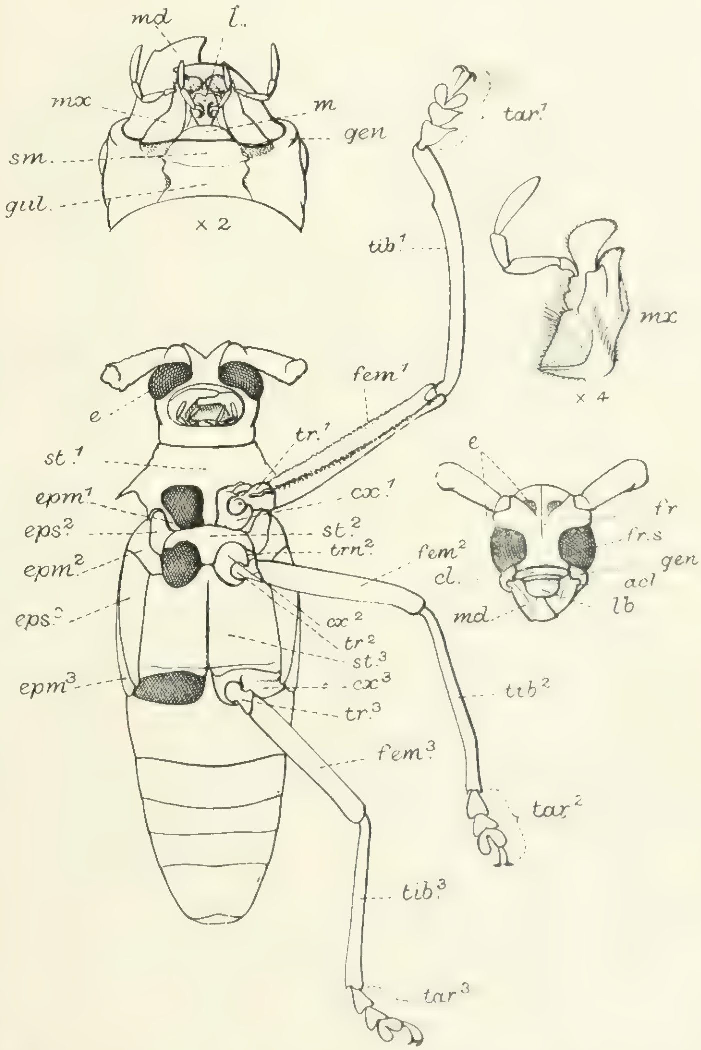


FIG. 29.—Longicorn beetle (*Batocera*). Ventral view, legs removed on one side. *e*, eye ; *cx*¹ ² ³ coxae of front, middle, and hind leg ; *tr*¹ ² ³ trochanter of ditto ; *fem*¹ ² ³ femora of ditto ; *tib*¹ ² ³ tibiae of ditto ; *tar*¹ ² ³ tarsi of ditto ; *st*¹ ² ³ prosternum, mesosternum, metasternum ; *trn*², trochanter of middle leg ; *epm*¹ ² ³ epimera of prothorax, mesothorax, and metathorax ; *eps*², episternum of mesothorax ; *eps*³, episternum of metathorax. Front of head :—*e*, eye ; *fr*, front ; *fr.s*, frontal suture ; *acl*, ante clypeus ; *cl*, clypeus ; *lb*, labrum or upper lip ; *md*, mandible. Undersurface of head enlarged :—*gul*, gula ; *gen*, gena ; *m*, mentum ; *sm*, sub-mentum ; *md*, mandible ; *l*, labium ; *mx*, maxillae.

scutellum. Occasionally the elytra leave a few of the posterior segments of the body visible, which are known as the pygidium. The elytra are always present in beetles, even in cases where there are no lower wings to protect (as e.g. in the longicorn *Teledapus*, p. 280). In the latter case they are often joined together down the central suture and are immovable. This central suture, however, is always perceivable. When the beetle wishes to fly, the elytra part down the suture and open out laterally and upwards to allow of the lower wings being expanded. In some instances, as in the rose-chafers (p. 91), the elytra are joined together in this way though under-wings are present, and they are then raised as one piece to permit the lower wings to be expanded when the beetle takes wing. The elytra are occasionally sculptured in curious fashion, and may have bunches of hairs protruding in parts as in the case of *Thysia wallichii* (fig. 17). The second pair of wings when not used in flight are folded up beneath the elytra. They are membranous and set with well-marked nervures or veins which are broken across at certain points to permit of the wings being folded up when the insect is not on the wing. These veins are used in some instances in classification.

In the legs three to five visible tarsal joints are present, and some of these joints may be bilobed. The tarsi are set with a spongy felt-work of hair which enables the insects to walk about on bark, plants, etc. The last tarsal joint ends in a pair of claws. In the abdomen five to six segments are visible on the ventral surface.

There is often a considerable difference in the appearance of the two sexes in the Coleoptera. The females are sometimes larger than the males, and the antennae in the male may be much longer than in the female, or the tarsi may vary in size, or the number of tarsal joints may vary in the two. Individuals of the same species also vary very greatly in size, as is shown in the four individuals of the longicorn beetle *Hoplocerambyx spinicornis*, shown in fig. 32.

Some beetles are capable of producing sound by having parts of their structure set with file-like processes which are rubbed over one another. The result produced is a squeaking noise; several Cerambycidae produce sounds of this nature, such as *Hoplocerambyx*, *Æolesthes*, etc.

In the glow-worms and fire-flies, which are beetles, light is produced by the oxidation of proteid matter in the abdomen.

The eggs of beetles are in forest forms mostly soft globular or elliptical bodies, semi-translucent or opaque white. These may be deposited in crevices in the bark, or the beetle tunnels into the tree and deposits them in prepared receptacles in the bast or wood. In the cases where the eggs are laid in the open they are hard externally, and usually whitish or greyish in colour.

The larva is grub-like, having a distinct head and jaws. It is sometimes furnished with antennae, and may have three pairs of feet on the front portion of the body. The different families vary in this respect, however, as shown

in the various coleopterous larvae figured here. In some cases (nearly all *Adephaga*) the tarsi are two-clawed. The body occasionally ends in anal cerci.

No special boring apparatus is present in the grubs, merely a pair of stout mandibles in most instances. The body may have series of tubercles arranged in definite parts on it and breathing spiracles on the sides (cf. *Hoplocerambyx* larva), and hairs either singly or in tufts.

The pupa is characteristic, usually white or yellowish-white in colour in tree forms, and is at first a rough caricature of the future beetle. Its shape varies, as shown in the figures (fig. 31), according to the future shape of the beetle. When the latter has attained its full development it remains quiescent in a resting stage whilst its outer hard chitinous parts are solidifying.

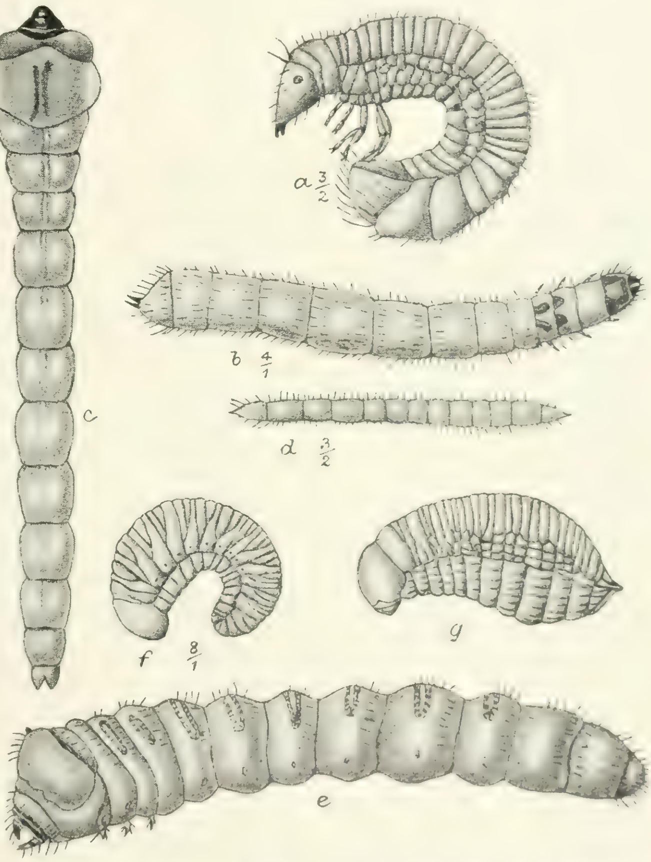


FIG. 30.—Coleopterous larvae. *a*, Scarabaeidae; *b*, Cleridae; *c*, Buprestidae; *d*, Elateridae; *e*, Cerambycidae; *f*, Scolytidae; *g*, Curculionidae.

CHARACTERISTICS AND HABITS OF THE ORDER.

The order Coleoptera may be considered to contain collections of insects which are perhaps more injurious to trees than any similar series of insects belonging to the other great orders of the Insecta. Whilst other great orders can show families or series of families containing insect predators or parasitic insects of high economic importance to the forester as assisting him in protecting his forests from pests, the Coleoptera, so far as is at present known, offer few instances of insects beneficial

to man, most of the families consisting of pests whose whole sustenance is derived from the tree, or who look to the tree to provide food for their offspring.

This would be serious enough, having regard to its connection with that portion of the forester's work which deals with the disposal of his produce, if the insects only confined their attentions to the tree after it had died in the forest or been felled for sale purposes. For there are a number of pests who do so restrict their attentions, which are able to destroy very quickly the marketable value of the timber if they are given an opportunity of doing so. A much more serious phase of the life histories of Coleoptera is connected, however, with the large number of beetles who can only derive their sustenance from the green tree, and who require such trees to lay their eggs or oviposit in. Whatever be the attribute, whether due to instinct or some other acquired sense, these insects will never oviposit in dry trees, nor in trees that are in such a condition that they will become dry before the offspring hatching from the eggs laid by them have reached full development as grubs.

It is often said that beetles, e.g. bark beetles, never attack a green healthy tree standing in the forest. This is a complete fallacy.

In the ordinary balance of nature, in the primeval forest, the bark beetle, whose offspring depend for their sustenance on the green bast or green timber, will not attack a healthy tree. There is no necessity for it to do so. The balance of power is kept even in nature, and the insect can always find a sufficiency of sickly trees, whose death it hastens, or of green windfalls which provide the necessities of life both for itself and its future offspring. The forester's business is, however, to remove all such blots from his forests and to keep them clean. Also to raise per acre the largest number of trees possible. Given a year favourable to insect life, or a series of favourable years, and the numbers of a particular bark-beetle pest in the forest become so great that they are bound to attack the green standing crop, seeking out, of course, the weaker trees to commence with. Vast numbers of the insects are killed off by the outflow of resin or sap with which the healthy trees respond to the attacks. This very output, however, reduces the vitality of the trees, which gradually succumb to the enormous numbers of the foe attacking them, and the trees are in the end killed just as surely as if they had been girdled or felled by the forester.

The order Coleoptera, to a degree unusual in other orders, contains a number of pests, to be found principally perhaps in the great families Buprestidae, Cerambycidae, Curculionidae, Scolytidae, and Platypodidae, which demand for their sustenance green bast, green sapwood, or green heart-wood. It is for this reason that the order must be considered as one of the most important, perhaps the most important, to the forester.

The Coleoptera feed upon the tree in a variety of ways, some infesting the roots, as e.g. species of Melolonthinae, such as *Serica* (p. 76) and *Lachnosterna* on the sál-tree, and *Coelosterna* on the *Acacia arabica*.

Others, again, and perhaps by far the most dangerous, infest the bast

layer of the main stems or larger branches. Examples of such are some Buprestidae, e.g. *Sphenoptera* in the deodar; several Cerambycidae—*Trinophyllum* in the deodar, *Hoplocerambyx* and *Æolesthes* in the sál; numerous Scolytidae—*Scolytus* in the deodar, *Polygraphus* (p. 501) in the blue pine, long-leaved pine, and *Pinus gerardiana*, *Tomicus* (p. 552) in the spruce, blue pine, and long-leaved pine, *Sphaerotrypes* in the sál (p. 476) and *Anogeissus latifolia*, etc.

The Brenthidae also are to be found, so far as present investigations go, in the bast and outer sapwood, the grubs, who may be semi-predaceous, pupating in the latter. Species of *Ceocephalus* and *Prophthalmus* have been taken in trees in the Dun, Himalaya, and Assam (p. 389).

Other Coleoptera confine their attention to the upper part of the crown, where they are not particularly harmful in old trees.

Many beetles found, however, in this position also infest young growth, and they may then prove serious pests. Instances are to be found in the case of a species of *Polygraphus* infesting the deodar and blue pine; *Scolytus* in the deodar; *Pityogenes* in the deodar, blue pine, spruce, and *Pinus gerardiana* (p. 562); *Apriona* (p. 374) in the mulberry and the buprestid *Psiloptera* (p. 199) in the *Acacia arabica*; and in the *Cryptorhynchus* infesting the *Pinus longifolia* (p. 428) and the *Pinus khasya*, etc.

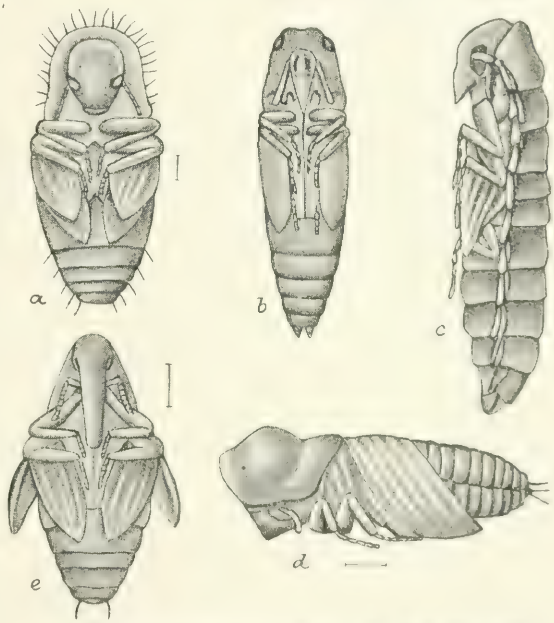


FIG. 31.—Coleopterous pupae. *a*, Bostrychidae; *b*, Buprestidae; *c*, Cerambycidae; *d*, Scolytidae; *e*, Curculionidae.

Others, again, destroy young seedlings. The grubs of the rhinoceros beetle *Oryctes* (p. 87) destroy young casuarina plants in this manner, whilst cryptomeria seedlings are destroyed by a species of *Lachnosterna* (p. 80), and deodar seedlings by species of *Melolontha* (p. 82) and *Elater* (p. 230). A species of scolytid, *Diamerus* (p. 472), kills young *Ficus elastica* seedlings by girdling them.

Damage is done to the leading shoots by the girdling propensities of some beetles, such as the deodar girdler *Scolytus deodara* (p. 578) and *Xylotrupes* (p. 90), which girdles young *Poinciana* trees in Burma.

Other beetles defoliate the tree, either feeding directly on the leaf as some Chrysomelidae (*Podontia*, p. 258) and Curculionidae (p. 405), or twisting

the leaf up into small rolls in which the egg is laid (*Apoderus*, p. 418). Some beetles actually feed upon the flowers of the tree, such as the blister beetle *Mylabris* (p. 247), which devours the flowers of the *Artocarpus* and many shrubs; and the chrysomelid *Pseudocolaspis* those of the chestnut (p. 266).

The damage to the seed from this order is probably extraordinarily heavy, though much investigation in this direction requires still to be carried out. The family Bruchidae are notorious for this form of damage, species of *Caryoborus* being known to destroy the seed of *Bauhinia* and *Tamarindus* (p. 251); Curculionidae also have been reported in this connection, *Alcides* infesting the walnut (p. 412), whilst a second weevil, *Calandra*, destroys the seed of the oak (*Q. incana*), (p. 446). A scolytid, *Coccotrypes*, infests the seed of the sál-tree.

Beetles do not, however, confine their attacks to the living portions of the tree. The timber is also infested, and often ruined commercially by the excessive numbers of beetles tunnelling into it for ovipositing or other purposes.

A variety of beetles infest the wood in this manner. It will be found that a tree lying in the forest newly felled, or a windfall, the result of some storm, will be infested by definite series of pests during each stage of its gradual death and drying up. When newly fallen the bark-borers will make their appearance. At the same time will come those beetles which lay their eggs in the bast, and whose grubs at first feed there, but subsequently go down into the sapwood for their nutriment. Most Buprestidae and Cerambycidae and many Curculionidae feed in this way. Some of these grubs when full-fed, however, tunnel right down into the timber of the tree to pupate, such as, e.g., the *Hoplocerambyx* of the sál, and thus ruin it for commercial purposes. Other beetles, such as the Platypodidae and some Scolytidae, go straight down into the heart-wood and lay their eggs there. These insects pinhole the timber, and when they are in abundance equally ruin it for commercial purposes. Instances of this latter method of attack in green fresh timber only are *Crossotarsus* (p. 613) in deodar, *Scolytoplatypus* in silver fir (p. 604), and búk (*Quercus lamellosa*) (p. 607), *Xyleborus* in teak, pyinkadu, sál, etc. (p. 582), *Platypus* (p. 619) in *Pinus longifolia*, *Platypus* (p. 621) in *Adina* and *Anogeissus*, *Diapus* (p. 628) in oak, and *Diapus* (p. 630) in *Shorea robusta*, etc.

Other beetles which infest freshly felled timber, but will also tunnel into timber of a somewhat drier nature, are the *Sinoxylon* beetles *S. crassum* and *S. anale* (p. 152), which attack the sissu. They both have a wide range, and, as we have seen, also infest sál, *Terminalia*, and other trees.

There are other classes of beetles which will not touch fresh green sappy timber, and which only make their appearance in the tree after the sap has dried off to a considerable extent.

Several species of Cerambycidae attack the tree in this way, a common example being *Plocœderus* (p. 295), which is to be found deep down in the sapwood of *Odina wodier*, sál, and other species, in trees which may have been felled a couple of years or so before. *Stromatium barbatum* (p. 291) infests dry timber.

A large species of *Elater* is to be found in dead pyinkadu. Perhaps the family Bostrychidae contains the most abundant numbers of wood-borers, such as species of *Heterobostrychus* (p. 146) and *Sinoxylon*.

Others are to be found amongst the Anthribidae, such as *Xylinades* and other anthribids (p. 386), in pyinkadu. The Cossoninae (Curculionidae) contain species of *Rhyncholus* (p. 451) which infest coniferous trees in the Himalaya. There are many Scolytidae whose attacks are confined to dry wood, such as some species of *Hylastes* (p. 473) and *Xyleborus*, etc.

Finally there are a large series of Coleoptera which confine their attacks to rotting timber. In this group the first beetles to be considered are the Passalidae (p. 66). Species of this family have been commonly met with in sál in Assam, in sauer (*Betula*) and kharani (*Symplocos*) in the Eastern Himalaya, and in rhododendron in the Ootacamund Hills. The Lucanidae, or stag beetles, are also to be commonly found in rotting wood and stumps, the commonest instances of which are the *Lucanus lunifer* (p. 70) in oak stumps in the Western Himalaya, and *L. mearesi* in kharani in the eastern portions of the range. Many Nitidulidae (p. 107) and Cucujidae (p. 115), etc., are also usually to be found beneath the bark of rotting trees, and hosts of other tiny members of the little-known families.

The fact that the Coleoptera do not, so far as is at present known, contain a large number of predaceous insects as compared with the noxious ones has been alluded to. There are, however, fortunately several insects of the highest importance which fall within this category—the *Thanasimus* (Cleridae) (p. 186), predaceous upon the more pernicious of the bark-beetle pests of the Himalaya; the histerids *Niponius* (p. 102), *Platysoma* (p. 105), and *Paromalus* (p. 107), predaceous upon coniferous bark-beetle pests in the Western Himalaya. Several small and at present not well-known species of Staphylinidae (p. 99) and Colydiidae (p. 111) also fall within this category, as also do the species of *Alindria* and *Melambia* (Trogositidae, p. 114).

The carabid beetles *Anthia* (p. 95), *Scarites*, *Morio* (pp. 95, 96) are also of use as predators, as also in all probability are some of the forest-living Cicindelidae (p. 93), about whose habits little is at present known.

The Cucujidae contain useful insects which feed upon bark- and wood-borers, such as *Hectarthrum heros* (p. 116), predaceous upon *Sinoxylon crassum* in *Terminalia* in the Central Provinces, and upon bark-boring Scolytidae in *Nauclia sessiliflora* in Burma.

The Coccinellidae are one of the predator families of beetles *par excellence*, the greater portion of the family being predaceous.

The best-known instances at present are perhaps the *Vedalia* (p. 125), which feeds in both its larval and beetle forms on the sál-tree scale insect *Monophlebus*, and *Coccinella septempunctata* (p. 123), which feeds upon the *Aphis* of the blue pine, the *Lachnus* of the silver fir, and the *Chermes* of the spruce and silver fir, etc. A number of other species which will be referred to in these pages are known in this connection.

Classification of the Coleoptera.

Beetles are primarily classified into the following series, according to the tarsal joints present and to the form of the antennae :—

Lamellicornia.—Tarsus of all the legs five-jointed. Upper joints of the antennae produced in flat or thickened expansions to one side so as to form a

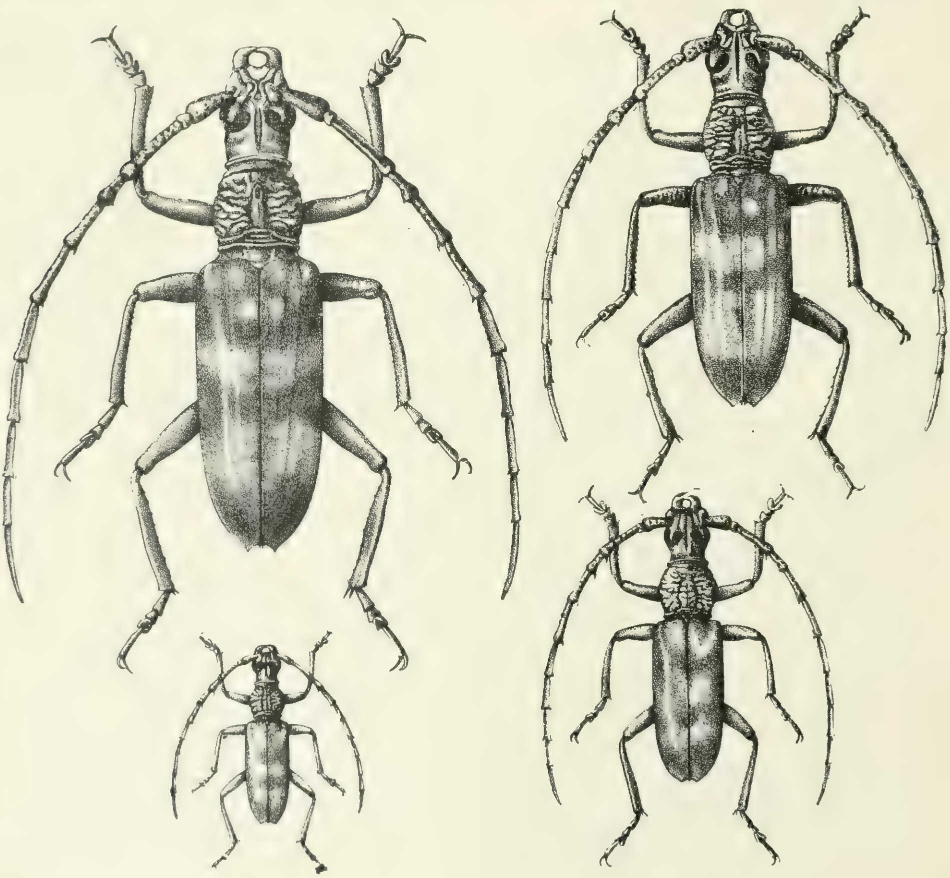


Fig. 32.—Example of the great variation in size of the same species of beetle. The insect depicted is *Hoplocerambyx spinicornis*, Newn.

club which is more or less compact, and can usually be opened out and closed at will.

Adephaga.—Tarsus of all legs five-jointed. Joints of antennae simple. Larva with two-jointed tarsi.

Polymorpha.—Tarsus of legs variable. Joints of antennae clubbed or serrate.

Heteromera.—Tarsus of two front pairs of legs five-jointed; of hind pair of legs four-jointed.

Phytophaga.—Tarsus four-jointed on all legs and densely pubescent. The head is not prolonged into a beak.

Rhynchophora.—Tarsus four-jointed on all legs and densely pubescent. The head is prolonged into a beak, which may be of considerable length.

For full details on the subject of classification, text books on entomology should be consulted. A book which will be available to all in India is Lefroy's excellent work *Indian Insect Life*, where the subject, so far as is at present possible, is fully dealt with.

FIG. 33.—A beetle (*Heliocopris dominus*). The right elytron is in the position of rest; the left is partially removed; the lower wing is spread in the position of flight.

CHAPTER VI.

LAMELLICORNIA.

Tarsi five-jointed. Upper joints of the antennae produced in flat or thickened expansions to one side, so as to form a club, which is more or less compact, and can be opened out and closed at will. The larvae have a characteristic shape, the lower part of the body being swollen out in a bag-like manner (cf. fig. 30*a*).

This division is easily recognizable. The three families Passalidae, Lucanidae, and Scarabaeidae will be considered.

Family PASSALIDAE.

The Passalidae are a family of shining black or brownish beetles, commonly met with in decaying or dead trees or stumps in the forest. The beetles reach about one and a half inches in length, with shining prothorax, which is large and squarish, and are easily recognizable by the prominent longitudinal ridges which run down the elytra alternating with rows of punctures. These elytra cover the whole of the body.

The antenna curls upwards, so that, when at rest, the upper prolonged joints remain in contact with each other. When the insect is motionless the antennae are usually held close beneath the head. The mandibles are large and prominent.

The under-surface of the body is covered with a long, brownish pubescence, the legs being rather broad, long, and adapted to propelling masses of dust and soft woody debris backwards.

The larva resembles the usual lamellicorn grub, being bulky, curved, with a prominent yellow head, and bulky posterior segments. The first pair of legs are short, striated, and stridulating sounds are produced with them.

Both larva and beetle, the former when full-grown, apparently emit a blackish liquid when touched or alarmed.

The Passalidae are practically confined to the forest areas of the country.

I have never found either the beetle or grub in solid timber, but they have been taken plentifully, in various parts of India, in the rotting timber and stumps of several species of tree. Since the insects are so often come across in the forest, it is necessary that the species which have been met with should be briefly alluded to.

Leptaulax.

Leptaulax darjeelingi, Knw.

Reference.—Knw. *Nov. Zool.* v, p. 298 (1898).

Habitat.—Darrang, Goalpara, Assam. Also reported from Mungphu; Tenasserim.

Trees Attacked.—India-rubber (*Ficus elastica*): Charduar Rubber Plantations, Darrang; Sál (*Shorea robusta*), Semul (*Bombax malabaricum*): Goalpara.

Description.

Beetle.—Moderate size, black, shining. Head flat, dorsal surface elevated in a number of prominent irregular pointed tubercles; mandibles prominent, ending in two teeth. Prothorax square, convex, shining, a rather deep median longitudinal depressed line not reaching to anterior or posterior edges; a circular punctate depression in the outer anterior angles; the lateral edge punctate. Elytra bluntly constricted apically, striate-punctate, the outer striae and punctures most prominent. Under-surface brown, shining, the sides of abdomen punctured. Length, 20 mm. to 28 mm.

Life History.

I took a number of these beetles from the interior of a felled dead stem of a rubber-tree in the Charduar Rubber Plantation on 8 April 1906.

Fig. 34.—*Leptaulax darjeelingi*, Knw. Goalpara, Assam.

The larvae were feeding in the soft decaying wood, and the beetles, which were fully mature, were apparently ovipositing in the wood beneath the bark.

A few weeks later Mr. W. F. Perrée and myself took numerous specimens of this beetle in the dead tops of large felled trees, in the Goalpara Sál Forests, in April and May. Subsequently we took numbers in a decaying fallen semul-tree of great size, in the Kochugaon forests.

Mr. Perrée was under the impression that he had taken the beetle in sál wood amongst piles of sleepers, but at present this surmise has not been substantiated.

Leptaulacides.

Leptaulacides roepstorffi, Knw.

Reference.—Knw. *Nov. Zool.* v, p. 288 (1898).

Habitat.—Andaman Islands.

Tree Attacked.—Species unknown.

Description.

Beetle.—Small. Reddish-brown, shining, prothorax darker. Head set with corrugate imbrications. Prothorax flat, very shining, anterior edge concave, posterior convex, a median longitudinal depressed line and a small depressed pit on lateral margin one-third up from posterior edge. Elytra conjointly constricted apically, striate, the interstrial spaces flat and shining. Under-surface brown, shining. Length, 15 mm. to 19 mm.

This beetle is reported to be common beneath the bark of rotting tree-stems in the Andaman Islands. No information is at present available as to the species of tree it infests or as to the habits of the insect.

PLEURARIUS.

Pleurarius brachyphyllus, Stolicz.

REFERENCE.—Stolicz, *Jour. Asint. Soc.* ii, p. 152 (1873).

Habitat.—Ootacamund Hills, Southern India.
Tree Attacked.—Rhododendron sp.

Beetle.—A large beetle.

Description.

Black, shining, clothed with a long dense red-orange pubescence on the posterior ventral parts of prothorax, meso- and metathorax. Head strongly tuberculate, mandibles large, clypeus densely hirsute, as are antennal joints and edges of legs. Prothorax very convex, shining, a deep depression medianly on lateral margin. Elytra flat on disk, striate-punctate, the punctures fine. Under-surface black, flat, shining. Length, 37.5 mm. to 45 mm.

FIG. 35.—*Pleurarius brachyphyllus*, Stolicz. Ootacamund.

Life History.

During a visit to the Eucalyptus plantations of the Ootacamund Hills I found this passalid beetle in considerable numbers in rotting stumps of Rhododendron sp. The beetles were taken in tunnels in the decaying wood, large orifices being visible on the outer surface and numerous winding galleries inside. The beetles, and a few larvae, were taken about the middle of August 1902.

BASILIANUS.

A species of this genus is common in the Eastern Himalaya.

Basilianus cantori, Perch.

REFERENCE.—Perch. *Mag. Zool.* p. 3, t. 134, f. 2 (1844).

Habitat.—Eastern Himalaya; Loolagaon, 5,000 ft., and elsewhere in the Sikkim Forests. Also reported from Tenasserim.

Trees Attacked.—Sauer (*Betula cylindrostachys*); Musre Katus (*Castanopsis tribuloides*); Kharani (*Symplocos theæfolia*). Sikkim.

Beetle.—Large, shining, black. Head set with prominent pointed tubercles, the mandibles large and toothed.

Description.

Prothorax not very convex, very shining, the median longitudinal depressed line not prominent or absent. Elytra strongly striate, interspaces smooth, shining. Under-surface black, shining, the lateral edges of thorax with a long bright red pubescence which also clothes the edges of legs. Length, 30 mm. to 34 mm.

FIG. 36.—*Basilianus cantori*. E. Himalaya.

Life History.

This beetle was first taken in rotting sauer and kharani trees, on 28 April 1896, at Loolagaon, in Sikkim. I subsequently took it plentifully in these trees and in decaying musre katus stems

in July. It is plentiful in this locality, between 4,500 ft. and 6,000 ft. The beetle was never taken in sound timber. It would seem probable that the insect matures at irregular intervals in the spring and summer months. It is to be found in the larval stage in the autumn and winter, making irregular ramifying tunnels in the soft, decaying sapwood, beneath the bark of standing or fallen rotting stems.

It has also been reported from Jaunsar, in the North-west Himalaya, at 5,000 ft. elevation, at the end of April.

ACERAIUS.

Aceraius hirsutus, Knw.

REFERENCE.—Knw. *Nov. Zool.* v, p. 343 (1898).

Habitat.—Evergreen Forests, Bhorelli River, Darrang, Assam.

Trees Attacked.—*Terminalia, Shorea, Lagerströmia, Schima.* Evergreen Forests, Darrang, Assam.

Beetle.—Large, shining, black; sides of thorax and basal half of elytra densely hirsute. Head large, vertex with sharp irregular raised lines and points, the depressions hirsute; eyes large and prominent; mandibles large, toothed. Prothorax wider than long, convex, smooth and shining; a more or less circular pitted depression on lateral margin just below the centre. Elytra constricted apically, shining, striate-punctate, striae very fine. Under-surface black, duller. Length, 31 mm. to 38 mm.

Description.

Life History.

I took numbers of this beetle, some large, others of small size, in the rotting wood of fallen decaying trees of the genera *Terminalia, Shorea, Lagerströmia,* and *Schima,* in the Evergreen Forests, near Bhorelli River, about the middle of April 1906. The beetles were only found in decaying trees, and were all either in the semi-pupal or mature state. I know nothing further on the life history of this insect.

Family LUCANIDAE.

(Stag Beetles.)

The Stag Beetles are easily recognizable owing to the great development of the mandibles of the males into prolongations having some resemblance to a stag's antlers (fig. 37). The females do not possess these exaggerated mandibular structures, their short thick black biting jaws being of the normal size. The beetles are usually large bulky insects, the males being larger than the females. The enlarged end joints of the antennae are characteristic of the family, since they are fixed into a straight cone-shaped knob instead of forming movable plates. The visible segments of the abdomen are five in number.

There is an extraordinary variation in the size of the beetles of one and the same species. This great variation has been noticed in some Cerambycidae (fig. 32), and also in the Buprestidae.

The beetles are usually black or greenish black, and occasionally brownish in colour; rather flat; the head large and prominent, with divided eyes; the prothorax very large, squarish in shape; the elytra large, constricted behind, and shining; the legs long, with elongated spined tibiae, and long tarsi in which the five joints are easily discernible.

The larva is a large, cumbersome, whitish-yellow grub, with well-marked horny head, jaws, and antennae. The legs are long and stout, the front ones not short as in Passalidae. The large body is soft, fleshy, the posterior segments being curved, the last two swollen in a bag-shaped manner.

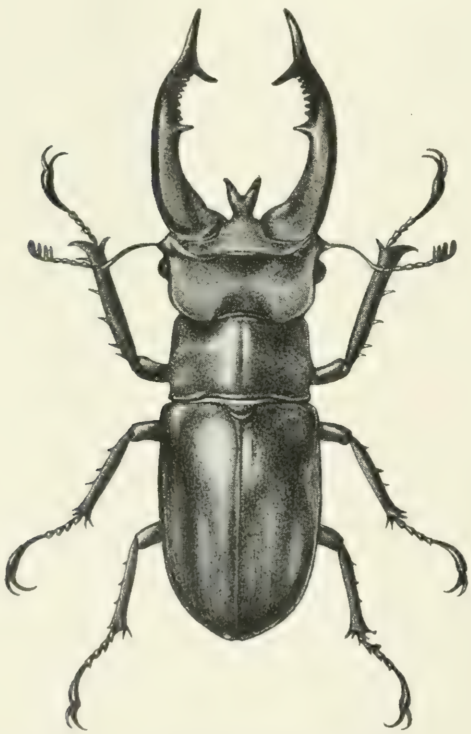


FIG. 37.—*Lucanus lunifer*, Hope. The Stag Beetle. ♂. Himalaya.

The pupa is thick, fleshy, and stout; whitish in colour.

This family of beetles lives in the mountainous forest areas of the country, being especially plentiful in the Himalaya. They have not been found in the forests of the plains. They do not infest living or freshly dead trees, the larvae, in spite of their powerful jaws, being unable, owing to the swollen soft bag-like abdomen, to move about in hard timber. All stages of the insects are invariably found in decaying timber in the forest. The beetles fly at night; but, as Himalayan *habitués* well know, are often to be found on shady woodland paths or on tree-trunks in the shade in the day-time.

A few of the species of trees inhabited by this family are known.

LUCANUS.

Two species of the genus have been reported from the forests.

Lucanus lunifer, Hope.

REFERENCES.—Hope in Royle, *Himal. Ins.* 55, t. 9, f. 4; Thompson, *Rep. Ins. destr. Woods and For.* 1868.

Habitat.—Himalaya.

Trees Attacked.—Moru Oak (*Quercus dilatata*); Ban Oak (*Quercus incana*). Western Himalaya.

Beetle.—♂ Large, elongate, black or greenish black, clothed with a very short greenish pubescence; the elytra shining, occasionally coppery brown. Vertex of head shield-like, the edges raised, central area depressed; the anterior margin sinuate, the outer angles and median part produced forward; front of head slopes downwards, the anterior edge produced into a median bifurcate prolongation. Eyes large. Mandibles enormously developed into two long horns having a resemblance to a stag's antlers; the antennae are long, elbowed, and prominent. Prothorax wider than long, with a median longitudinal depressed line. Elytra convex, apex conjointly rounded. Scutellum large, wide, anterior edge concave, posterior convex. Legs long, tibiae spined. Pubescence on under-surface denser, especially on metathorax. Abdominal segments brownish. Length, 36 mm. to 75 mm.

Description.

♀ Smaller than the male, the black mandibles of normal size; the front of head is coarsely rugose-punctate.

Larva.—Large, stout, fleshy, curved and corrugate, with three pairs of legs on thoracic segments; abdominal segments swollen in a bag-like manner behind. Head large, brown, and shining; mandibles large, black. Length, 50 mm. to 85 mm.

Life History.

In the outer Himalaya the mature beetles are to be found on the wing in June, July, and later in September. The beetles probably issue irregularly throughout the summer, as I have taken fully developed larvae just pupating, as also pupae and mature beetles, in rotten oak-stumps in July. The length of time passed in the larval stage is unknown. It possibly exceeds a year. Before pupating the larva forms a rough kind of semi-cocoon with shreds of wood. The pupal stage is short, a month or six weeks at most; but the beetle spends some time in the "resting" stage whilst its outer chitinous parts are slowly solidifying. At this period the beetle is light brown in colour, this tint slowly darkening as the outer covering hardens.

FIG. 38.—*Lucanus lunifer*, Hope. ♀

The female beetle lays her eggs in crevices of the bark or creeps under projecting flakes and deposits them on the outer surface of the sapwood. The tree selected is invariably a dead one in which the wood has already undergone considerable decay. In no cases have I ever found the grubs or beetles in sound timber; nor have I been able to find any corroboration of the statement made by Thompson in his *Report on Insects Destructive to Forests* * that these beetles and their grubs destroy oak timber. In *Injurious Insects* † I alluded to this matter so long ago as 1899, and investigations made since have confirmed me in the view I then expressed, which was also held by Mr. W. F. Blandford, formerly Lecturer in Entomology at Coopers Hill. Mr. Thompson wrote: "The stag beetles are both numerous and common in individuals, and are, of the whole order of wood beetles, the most destructive to living trees. Some idea may be formed of the ravages

* p. 16.

† *Inj. Ins. Ind. Forests*, p. 32 (1899).

of these insects when it is stated that the larvae live from three to four years in that state in the interior of the trunks of oaks, and that barely one in ten of the trees to be met with in Nyne Tal does not bear the marks of their ravages. These and larvae of *Prionus* beetles seem to exclusively attach themselves to the oak as their habitation. . . . They bore circular chambers, penetrating to the heart of the stem, winding into various passages both up and down the trunk. They eject the undigested particles through holes made for the purpose, forming lateral communications with the main tunnels; these particles may be observed at the roots of the trees so affected in the form of small lengthened chips."

The *Prionus* beetle referred to by Mr. Thompson is the cerambycid *Lophosternus hugelii*, whose life history is detailed on p. 274. It is the work of the larva of this beetle which Mr. Thompson appears to have confused with that of the lucanid ones.

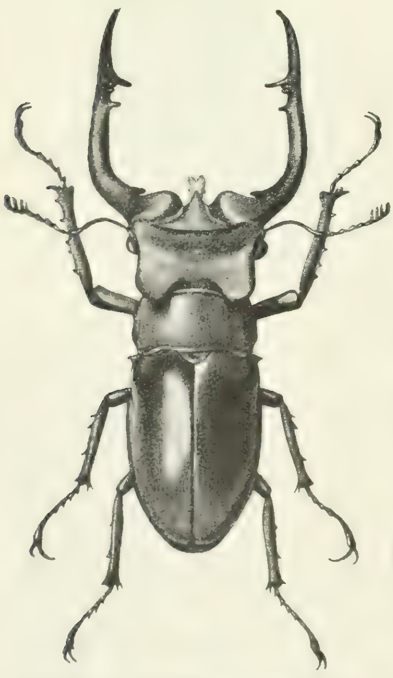
As has been shown, lucanid larvae cannot at present be considered as of economic importance to the forester.

Lucanus mearesi, Hope.

REFERENCES.—Hope, *Proc. Ent. Soc.* 83 (1842); *Ann. Nat. Hist.* xii, 4, 364.

Habitat.—Darjeeling.

Tree Attacked.—Kharani (*Symplocus theæfolia*). Darjeeling (C. G. Rogers).



Beetle.—**Description.** Resembles *lunifer*, but is smaller, the elytra with a golden or purple reflexion. The ♂ can be distinguished by the different shape of dorsal surface of head, the anterior margin of vertex being nearly straight, the outer angles but slightly produced, the margin being only slightly sinuate. In the ♀ the front of head is much less coarsely rugose-punctate. Length, ♂ 35 mm. to 64 mm. ♀ smaller.

Life History. This lucanid was reported from the Darjeeling forests by Mr. C. G. Rogers, Conservator of Forests. Mr. Rogers stated that it bores into the dead sapwood of the kharani-tree at elevations of from 5,000 ft. to 6,000 ft. above sea-level.

FIG. 39.—*Lucanus mearesi*, Hope. ♂ and ♀. Himalaya.

Family SCARABAEIDAE.

(*Dung Beetles and Chafers.*)

This is a very large family of beetles, including several sub-families; the Scarabaeinae or Dung rollers; Melolonthinae or Cockchafers; the Rutelinae; the Dynastinae; and the Cetoniinae or Rosechafers. Only the Melolonthinae, Rutelinae, Dynastinae, and Cetoniinae are of importance in the forest.

The beetles of the family may be recognized by the fact that the leaflets of the club form little plates which are easily opened out and closed. The elytra leave the pygidium exposed, and the number of ventral segments of the abdomen visible is six. The beetles are thick, bulky insects, some of large size, with a flat head and the prothorax large, often spined, and the front tibiae flattened and spined, the front pair of legs being often used for digging purposes. Black, yellow, brown, or grey colouring predominates, save in the Cetoniinae, where green and copper are also present.

The larvae (fig. 30, *a*) are large, thick, curved, and much-corrugated grubs, with a large brown head and three pairs of legs, and resemble the lucanid grubs.

Both beetles and grubs of the four sub-families we are concerned with feed upon plants, the grubs on the roots and other parts of young seedlings, and the beetles on the leaves or flowers. The grubs of some species have been observed or reported as causing serious damage to seedlings; deodar sowings have suffered from the attacks in the Western Himalaya, and casuarina in the plantations in Madras.

The larval life is thought to extend over more than one year, in some instances perhaps over several years, the grubs feeding voraciously during this period, save during the winter months in the colder climate of the hilly districts, when they burrow deep down in the soil and hibernate. The pupal stage is in many instances short, but the beetles spend a more or less lengthy period in the soil in the "resting" state whilst their outer hard chitinous parts are solidifying. Immature beetles found in this stage in the soil are light yellow or yellow brown in colour.

MELOLONTHINAE.

The beetles have no horns on the head or prothorax, and one spiracle is visible on the pygidium. The beetles are of moderate size, with thick bodies and front legs flat and broad and adapted for digging.

The sub-family is divided into several divisions, of which genera of the Sericini (*Serica*) and Melolonthini (*Lepidiota*, *Holotricha*, *Melolontha*) only will be considered.

SERICA.

A common forest genus of cockchafers of moderate to small size, and yellow, brown, or dark brown-black in colour.

Serica alcocki, Brenske.

REFERENCES.—Brenske, *Ind. Mus. Not.* iv, 217; Ibid. vi; Stebbing, *Depart. Notes*, i, 10 (1902).

Habitat.—Dehra Dun.

Tree Attacked.—*Mallotus philippinensis.* Dehra Dun (C. G. Rogers).

Description.

Beetle.—A smallish thick brown beetle, black to plum-coloured above. Clypeus rounded, thickly but lightly punctate; last joint of the maxillary palpus short, ovate, or pointed. Antennae slender, ten-jointed, the club consisting of three small plates. Prothorax convex, rounded at sides. Scutellum small, broad. Elytra broadly striate, the striae irregularly punctate, the channels finely punctate. Thighs broad, not spined; hind tibiae slightly dilated, front ones with two teeth. Length, 6.4 mm.

Life History.

This *Serica* was discovered by Mr. C. G. Rogers, I.F.S., on 16 June 1896. Mr. Rogers took the beetle from the leaves of *Mallotus philippinensis* in the Dehra Dun sál forests. The beetle feeds on the young tender succulent leaves of the tree, nearly the whole of the leaf, with the exception of the midrib, being eaten. The beetle, as observed by Mr. Rogers, commences feeding on the leaf either at the edge or in the middle, but apparently confines itself to the young leaves. It was not observed to eat the old hard ones.

This beetle, like several other members of this sub-family, drops off the food-plant to the ground when disturbed or frightened, and Mr. Rogers noticed that it was then extremely difficult to detect amongst the dead leaves and decaying vegetation of the forest floor. Investigation has not yet shown on what tree the grubs of this species feed. They may feed on the roots of the *Mallotus* or upon those of the sál, *Terminalia*, and other trees growing in this locality.

Serica assamensis, Brenske.

REFERENCES.—Brenske, *Ind. Mus. Not.* iv, 176 (1899); ibid. v, 14.

Habitat.—Bengal Duars, Assam.

Tree Attacked.—Tea-plant (*Camellia thea*) (Messrs. Andrew and Yule); Sál (*Shorea robusta*). Bengal Duars.

Description.

Beetle.—Brown, the head and prothorax reddish brown. Clypeus obscurely three-toothed, rather broad, finely punctate, and furnished with very short spines, the median line slightly keeled. Antennae ten-jointed, joints two to seven very short, the terminal joint faintly three-lobed in both sexes, and scarcely longer in the male. Prothorax broad, sides slightly rounded anteriorly, straight behind; posterior angles obtuse. Elytra with a series of striae, the interspaces between them but slightly convex. Thighs and tibiae slightly broadened posteriorly. Length, 6 mm. to 6.8 mm.; breadth, 4 mm. to 4.3 mm.

Life History.

In April 1899 this beetle was reported to be seriously defoliating tea in the Duars tea gardens close to the Bhutan Hills. The beetle suddenly appeared in the gardens on 12 April in large numbers, and stripped the tea-bushes of the new leaves of the year, as also the new shoots. An examination of the

soil at the roots of the tea-bushes showed the beetles to be in large numbers there, it thus becoming evident that the grub of this insect feeds upon the roots of the tea-bush. The account of this attack is given in *Indian Museum Notes*, vol. v, p. 15.

In 1895–6 I found the grubs, pupae, and beetles of this *Serica* at the roots of sál-trees in the Bengal Duars, the grubs feeding on the smaller roots of the tree. The grubs and pupae were taken in March, and mature beetles in the soil at the beginning of April. I am unable to say whether the beetles defoliate the sál-tree.

Serica calcuttae, Brenske.

REFERENCES.—Brenske, *Ind. Mus. Not.* iv, 176; ibid. v. 130.

Habitat.—Calcutta.

Tree Attacked.—Rosa sp. Calcutta.

Beetle.—♂ Similar in size to the last species. Front of head carinate. Antennae ten-jointed, the antennal plates compressed and short. The elytral interspaces broadly convex. The posterior thighs broadened apically; the tibiae strongly broadened behind. Length, 8 mm.; breadth, 5 mm.

This beetle was found on rose-bushes in the compound of the Indian Museum, Calcutta. Nothing further appears to be known of its life history.

Serica pruinosa, Burm.

REFERENCES.—Burm. *Handb.* iv, 2, p. 165; *Gem. Har. Cat. Coleop.* iv, p. 1120; Cotes, *Ind. Mus. Not.* iii, 117.

Habitat.—Madras Presidency: Devikulam; Trevandrum.

Tree Attacked.—Coffee (*Coffea arabica*, Linn.). Devikulam, Madura District (A. W. Turner).

Beetle.—Ovate. Black or smoky-black; antennae and tarsi brown. Front of head finely rugose. Prothorax wider than long, sides rounded in front, straight behind; rugose, dull. Elytra striate, the intervals raised and slightly rugose, sparsely clothed with a short pubescence. Under-surface black, rugose. Tibiae of hind legs strongly broadened. Length, 6–7 mm.

FIG. 40.—*Serica pruinosa*, Burm. Madras.

Life History.

The beetle has been reported as seriously defoliating coffee-bushes at Devikulam at a height of between 5,000 ft. and 6,000 ft. in the Madura District. Mr. A. W. Turner found the beetles devouring the leaves of the bushes in June 1892. Nothing further appears to be known about the insect.

Serica sp.

Habitat.—United Provinces Sál Forests.

Tree Attacked.—Sál (*Shorea robusta*). Horai.

Beetle.—Ovate. Very dark chestnut-brown, almost black. Prothorax wider than long, sides rounded; surface finely punctate, dull. Elytra rather finely striate, striae less well defined laterally; the intervals convex, finely and irregularly punctate; dull, with a very short pubescence apically. Tibiae of hind legs very broad, tarsi lighter brown. Length, 9.3 mm. Described from a single damaged specimen.

Description.

Larva.—The larva is a smallish white, curved, crinkled grub of about 18 mm. in length.

Life History.

I took one or two fully matured grubs, some pupae, and a mature beetle of this insect from the soil beneath the humus layer at the roots of sál-trees in the Horai Forest in the first part of May 1908. The grubs feed on the smaller roots of the sál and on the thinner bark of larger roots. The beetle issues on the wing during May and probably June.

Serica ? sp.

Habitat.—United Provinces Sál Forests.

Tree Attacked.—Sál (*Shorea robusta*). Horai.

Beetle.—Ovate. Red-brown, moderately shining, elytra yellowish brown, antennae and tarsi brown. Front of head finely rugose, with a transverse median carina. Prothorax wider than long, sides rounded, finely punctate. Elytra striate, the intervals rather broad, flat, and finely and fairly densely punctate, the lateral margins of whole insect fringed with longish brown spiny hairs. Under-surface brown, finely punctate; hind femora and tibiae broad. Length, 7.1 mm. Described from two damaged specimens.

Description.

This insect was taken in company with the last in the soil at the foot of sál-trees in the Horai Forest. The grubs feed on the roots of the tree. The food of the beetle is unknown.

Serica ? sp.

REFERENCE.—P. M. Lushington, The Insect Pests of *Swietenia macrophylla*, *Ind. For.* vol. xxxi, p. 74 (1905).

Habitat.—Nilumbur Teak Plantations.

Tree Attacked. — Blackwood or Rosewood (*Dalbergia latifolia*); Mahogany (*Swietenia macrophylla*) (P. M. Lushington).

Life History.

Very little appears to be known on the subject of this insect. In a note on the Insect Pests of the Mahogany (above referred to), Mr. P. M. Lushington recorded the following observations on its habits:—

"More serious damage seems to be done (to the mahogany) by an insect which I have been unable to discover. This attacks the leaves, but

more especially the mid-rib and sometimes the young shoot. The parts attacked turn brown, and on the mid-rib and shoot a scar is left, and the woody portions become subsequently affected. I am inclined to suspect that this damage is done by a small beetle allied to the Rose beetle: for, though I have never found this on the mahogany, it is plentiful on the neighbouring blackwood trees, where it damages the flower and flower-stalks in a similar manner. I notice that it emits a black fluid, which appears to be injurious to the leaves."

Lepidiota.

Lepidiota bimaculata, Saund.

References.—Saund. *Trans. Ent. Soc.* ii, 176 t. 16, f. 2 (1839); Burm. *Handb.* iv, 2, 294; *Gem. Har. Cat. Coleopt.* iv, 1163; *Griffithi*, Hope, *Trans. Ent. Soc.* iii, 62 (1841).

Habitat.—Assam. Also reported from Sikkim, Naga Hills, Khyokphow.

Tree Attacked—Sál (*Shorea robusta*). Assam.

Description.

Beetle.—A large beetle. Head, prothorax, and pygidium dull green, elytra brown, dull or slightly shining; under-surface black, clothed with a short greenish-yellow pubescence. Legs black. Head narrower than prothorax, dull, punctate. Prothorax wider than broad, sides curved and finely serrate; finely punctate. Scutellum large, heart-shaped, finely punctate. Elytra convex, finely punctate, widest medianly, basal angles rounded, constricting from middle gradually to apex, latter truncate; pygidium depressed. Anterior tibiae broad and three-spined. Under-surface convex, shining where pubescence has been rubbed off. Length, 46 mm. to 57 mm.; breadth, 24 mm. to 29 mm.

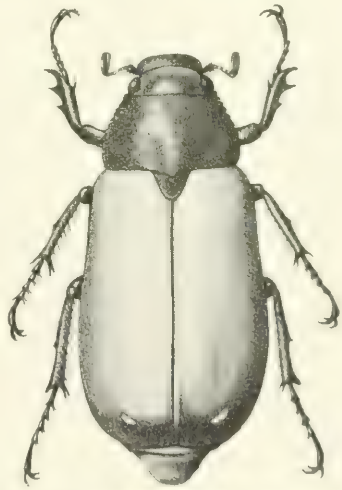


Fig. 41.—*Lepidiota bimaculata*, Saund. Assam.

Life History.

I took specimens of this insect in May in the Assam sál forests. The beetles were noticed sitting on leaves and twigs of sál-trees, and one specimen was seen to be feeding on the leaf parenchyma, eating out holes in the leaf. I know nothing further about its life history.

Lachnosterna.

Lachnosterna (Holotricha) problematica, Brenske.

Reference.—Brenske, *Ind. Mus. Notes* iv, p. 178 (1899).

Habitat.—United Provinces Sál Forests. Also reported from Srinagar.

Trees Attacked.—Sál (*Shorea robusta*): Horai, Kumaun, and Gorakhpur; *Terminalia belerica*, Jaman (*Eugenia jambolama*): Gorakhpur (A. E. Osmaston).

Description.

Beetle.—Dark-coloured, slightly iridescent above, with a thick white pubescence beneath. Front of head densely rugose, punctate. Antennae ten-jointed, finely and densely rugose-punctate. Prothorax broader than long, the angles rounded behind. Scutellum large. Elytra with slight costae, but not densely punctate. Pygidium acute behind, punctate. Length, 16 mm.; breadth, 8 mm.

Larva.—White, curved, crinkled, with a yellow head. Length, 25 mm.

Life History.

The beetle appears on the wing in the latter half of May in the sál forests of the Kumaun Terai, and from the first week in May in the sál areas of Gorakhpur. The eggs are probably laid during this month and in June. The larva feeds in the soil on the roots of the sál-tree. I took a number of larvae, pupae, and immature and a few mature beetles at the roots of sál-trees in the Horai Forest in the second week of May 1908. The grubs feed on the bark of the younger roots, eating it away in patches, and often completely girdling the roots. The grubs are full-fed in the latter part of April. The pupal stage appears to be about three to four weeks only, and the beetle on maturing pushes its way up from the soil through the humus and dead leaves above, and takes wing in the forest. Larvae, pupae, and beetles were all found in the upper inch of soil.

In May 1909 Mr. A. E. Osmaston, I.F.S., recorded some excellent observations he made on the beetle. He took beetles feeding on sál leaves at Bhillanpur in the Gorakhpur division on 7 May 1909, others at Banki on 10 May, and at Jagpur on 18 May. At Jagpur the beetles were also defoliating the *Terminalia belerica* and the jaman and other miscellaneous species of trees.

From the usual time of appearance of these Cockchafer beetles in the forest it would appear probable that this insect only passes through one life-cycle during the year. The grub thus spends the major portion of the year feeding on the roots of the tree, descending probably deeper into the soil to hibernate during the winter months.

Damage Committed in the Forest.

These melolonthid beetles have the power of increasing in incredible numbers in the forest under favourable conditions, and this insect is therefore a pest of first-class importance in the sál forests of the United Provinces. It is not improbable that the poor growth of young trees in soils unfavourable to the tree is due to the destruction of portions of the young root system by this and other melolonthid pests.

Protection.

Early in May 1908 a fire took place in the Horai Forest, and rather severely burnt out three compartments. All the undergrowth and young trees were burnt and old trees severely scorched. In the unburnt areas I took a considerable number of larvae, pupae, and immature and mature beetles in the soil at the foot of sál-trees, the dead leaves, humus, and upper layer of soil being

removed for a considerable distance round the base of several trees and the roots exposed. A series of observations were also carried out in the burnt-over area. I found that all the melolonthid and elaterid grubs in the first inch of soil had been carbonized, not a living grub of any description being taken. Fully mature *Serica* and *Lachnosterna* beetles were, however, still alive and apparently unharmed. This observation would seem to show that the fires which swept unchecked through the forests before the inauguration of fire protection must have taken a considerable part in keeping down those classes of pests whose grubs live in the soil or who retire to the upper layers of the soil to pupate, as, for instance, the defoliator *Boarmia selenaria* of these forests.

Macrochilus bensoni, Hope (p. 95).—The grub of this common carabid beetle is predaceous upon the grubs of *Lachnosterna problematica*, *L. clypealis*, and *Heteroplia varians* (described later), and probably also on those of the *Serica* sp. grubs which infest sál roots.

Predaceous Insect.

Beetle.—Elongate. Black, shining, with two orange spots on each elytron, legs yellowish brown, antennae and tarsi brown. Head flat, depressed laterally, strongly punctate; eyes greenish black, large round, placed at sides; mandibles stout, brown, as are the palpi. Prothorax wider than long, anterior margin straight, sides strongly rounded, base slightly so; surface convex, strongly punctate. Elytra wider than thorax at base, widest near apex and conjointly rounded; striate-punctate, disk but slightly convex. Pygidium small, black. Under-surface black, shining, densely and finely punctate. Legs long and slender. Length, 12 mm.

Grub.—The larva is elongate, tapering at both ends, with a large square yellow-brown head and powerful mandibles. The extremity ends in a pair of elongate processes.

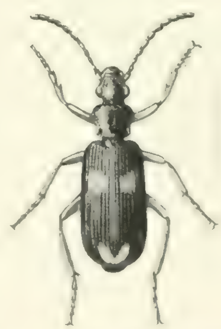


FIG. 42. *Macrochilus bensoni*, Hope. United Provinces.

Life History.—I took a few of these beetles and a larva or two in the soil at the foot of sál-trees in the Horai forests. The larva feeds upon the melolonthid one, seizing the grub in its mandibles, and, after piercing a hole through its skin, sucking out its body contents. The beetles fly at the commencement and throughout the early part of the rains.

Lachnosterna clypealis, Brenske.

REFERENCE.—Brenske, *Ann. Soc. Ent. Belg.* p. 150 (1900).

Habitat.—Garhwal, United Provinces.

Tree Attacked.—Sál (*Shorea robusta*). Garhwal Forests, United Provinces Terai.

FIG. 43.—*Lachnosterna clypealis*, Brenske. Garhwal.

Description. **Beetle.**—Elongate, parallel. Smooth. Head and prothorax dark chestnut, elytra lighter-coloured. Head small, flat, margined, rugose-punctate. Prothorax wider than long, finely punctate. Scutellum large. Elytra with sides slightly rounded, apex rounded, pygidium yellow, small; surface of elytra finely punctate with several ill-defined striae, the median one most prominent. Under-surface yellow; legs brown, tibiae spined. Length, 16 mm.

Life History. Specimens of this beetle, both mature and immature, were taken from the soil near the roots of living sál-trees in the Garhwal forests in April 1908 in a manner similar to that in which I took *L. problematica* already described. The grubs probably feed on the roots of the tree.

Lachnosterna intermedia, Brenske.

REFERENCES.—Brenske, *Mem. Soc. Ent. Belg.* ii, 64 (1894); Osmaston, *Ind. Forester*, xxviii, 352 (1902).

Habitat.—Darjeeling, Eastern Himalaya.

Tree Attacked.—Cryptomeria (*Cryptomeria japonica*). Darjeeling (B. B. Osmaston).

Beetle.—Elongate, parallel, smooth, dark chestnut in colour. Prothorax wider than long; finely punctate. Scutellum triangular. Elytra with parallel sides, constricted at apex, leaving pygidium of one segment exposed. Tibiae spined. Length, 20 mm.

The larva, pupa, and beetle are figured natural size after a drawing by Mr. B. B. Osmaston, reproduced from the *Indian Forester*.

Life History. This insect was discovered killing young cryptomeria seedlings by Mr. B. B. Osmaston, I.F.S., in plantations in the Darjeeling Division in April 1902. The following are extracts from Mr. Osmaston's note, dated 12 May 1902, on the attack, which was published in the *Indian Forester*:—

"I enclose a note on a cockchafer-like beetle found doing serious damage in a cryptomeria plantation last month. . . . .

"The damage is done by the larva, which gnaws all the bark off the main and lateral roots. The larvae were found killing cryptomeria seedlings two to three feet high and four to five years old in plantations near Hoon (Darjeeling), at an elevation of 5,000 to 6,000 ft.

"Specimens of the insect in all stages were found on 12 May 1902. But the beetles seemed in most cases to have already bored out from the ground and flown away.

"Only *one* beetle seems to attack each plant, but is quite able in most cases to kill it."

FIG. 44.—*Lachnosterna intermedia*, Brenske. Larva, pupa, and beetle. Darjeeling. (After Osmaston.)

This appears to be the first report of the insect from this locality, and no observations seem to have been previously recorded on its life history.

Lachnosterna impressa, Burm.

REFERENCES.—Burm. *Handb.* iv, 2, 314; *Gem. Har. Cat. Coleop.* iv, 1168; Cotes, *Ind. Mus. Not.* i, 50; id. *Tea Insects*, iii, 4, p. 5; Barlow, ib. iv, 261.

Habitat.—Darjeeling; Sikkim.

Tree Attacked.—Tea (*Camellia theifera*). Sikkim.

Beetle.—Stout, elongate, brown, rather shining, punctate. Prothorax wider than long. Scutellum heart-shaped. Elytra broadest in apical fourth, where they are much broader than prothorax; apices separately rounded, suture often slightly gaping at apex; pygidium exposed; tibiae spined. Length, 20 mm. to 25 mm.

Larva.—White, curved, crinkled, with prominent head, stout mandibles, and three pairs of rather long legs.

Life History.

This insect is very abundant in the Darjeeling forests and tea gardens, and is found throughout the Sikkim forests in the Kalimpong Division. The beetle appears on the wing from the end of March through April into May. The larva feeds on the roots of the tea and garden plants, and not improbably on the roots of seedlings of forest trees as well. In 1883 the grubs committed great havoc in the public gardens at Darjeeling, over two and a half millions of individuals having been collected. In 1891 the insect again made its appearance in the Darjeeling district, and killed off a large number of plants in the tea-garden nurseries. The full life history does not appear to have yet been worked out, but it is improbable that it passes through more than one life-cycle in the year.

HETEROPLIA.

Heteroplia varians, Oliv.

REFERENCE.—Oliv. *Ent.* i, 5, p. 78, t. 10, f. 123, *a*, *b*.

Habitat.—United Provinces Terai.

Tree Attacked.—Sál (*Shorea robusta*). Horai, Kumaun.

Description.

Beetle.—Stout, elongate, yellow, moderately shining; the head black, shining, margins of prothorax, scutellum, and elytra black; legs and antennae brown. Head small, punctate. Prothorax wider than long, sides rounded; smooth, very finely and lightly punctate. Scutellum large. Elytra broadest about middle, where they are broader than thorax, apex rounded, suture slightly gaping apically; surface smooth, very finely punctate; pygidium yellow; tibiae spined. Length, 18 mm.

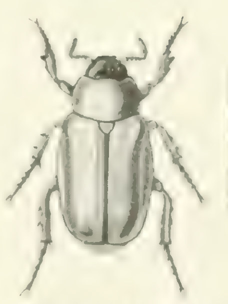


FIG. 15. *Heteroplia varians*, Oliv. Kumaun.

Mature and immature specimens of this beetle were obtained in the Horai sál forest in the United Provinces in the middle of May 1908. The insect was found in the soil at the roots of sál-trees in a manner similar to that in which I took *Lachnosterna problematica* and *L. clypealis* described above.

Life History.

MELOLONTHA.

Melolontha ? sp.

(*The Deodar Cockchafer Grub.*)

REFERENCES.—Stebbing, *Depart. Notes*, i, 87; Ins. Pests of Coniferae of Himalaya, *Ind. For. Mem. Zool.* ii, p. 63.

Habitat.—Western Himalaya.

Tree Attacked. — Deodar (*Cedrus deodara*). Jaunsar and Bashahr, Western Himalaya.

Beetle.—Unknown.

Larva.—The larva is a large, heavy, yellowish-white curved grub with a light brown head bearing two antennae and a pair of long curved very powerful mandibles. The body is thick and curved, the anterior segments being much corrugated, whilst the posterior three segments are swollen up in a bag-shaped manner, and are black in colour. Length, $1\frac{1}{2}$ in. to 2 in.

Life History.

So far as is at present known it is the larva of this cockchafer beetle which is dangerous to deodar growth. The grub cuts through the roots of seedlings and young plants, or more often gnaws away the bark all round, thus girdling them. Grubs apparently full-grown were found engaged in this manner in some patches of deodar sowings in the Taranda Forest, Bashahr Division, in June–July 1902.

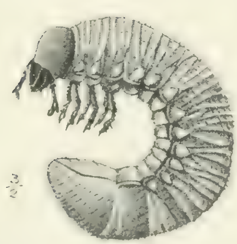


FIG. 46.—*Melolontha* grub of deodar. N.W. Himalaya.

In June 1909 a report was received from Mr. Billson, Divisional Forest Officer, Jaunsar, that patches of young deodar seedlings were suffering from grubs in a similar manner. The grub proved to be a melolonthid one, and not improbably identical with the one I found in Bashahr in 1902.

The rest of the life history of this insect has yet to be studied. It is probable that the beetle will be found on the wing some time during the summer months, and it may be that the larvae pupate at irregular intervals throughout the summer, so that some beetles will always be found between June or July and October. This point has to be definitely ascertained.

Damage Committed in the Forest.

So far as observations have yet gone this insect is only destructive to seedling and perhaps very young sapling growth, and the damage is done by the larva only.

Regeneration of the deodar has been carried out in the past to a considerable extent by sowing the seed in patches, and it has been a common

experience to find that the whole of these patches fail. The seed may germinate and the young plants come up and then apparently damp off. This apparent damping off is very often entirely due to the attacks of this cockchafer grub or the other root pests to be described in this work. In the past it has, however, almost invariably been ascribed to drought or frost or bad seed. The following description of a patch of deodar sowing examined by myself is typical of what occurs and of what took place in Mr. Billson's infested sowings:—

There were probably twenty-five seedlings originally in the patch. At the time of inspection five green unattacked ones were all that remained standing in the soil. Of the rest a few dead ones remained standing, and these came away in the hand, being cut through below the surface, or the roots came away with the dead upper part and were seen to be girdled. The rest had been cut off either at the apex of the stalk just beneath the crown of needles or below in the stem somewhere above-ground. This latter work was that of the *Agrotis* caterpillar, which was also present here. The work below ground was mainly that of the *Melolontha* grub, though an elaterid larva (see p. 230) was also found.

The girdling of the young plants is a serious matter, especially where several of these large larvae infest a patch of seedlings. Their presence practically means that the whole of the patch is doomed.

Protection and Remedial Measures.

Before making sowings of seed out in the forest it is advisable to turn up the soil for a couple of feet in selected spots to ascertain whether these root-feeding larvae are abundant on the area or not. If they are very abundant it is almost useless endeavouring to restock the area by means of sowings.

In nurseries matters are simpler, and Mr. Billson introduced with success one or more of the following remedies in the attack experienced in Jaunsar in 1909. Under certain circumstances one or more of the remedies might be attempted in the forest:—

(1) Before the young seedlings have come up place bundles of any succulent crop plant which may be growing in the neighbourhood (in America cabbage, turnips, and clover have been found most effective) at intervals on the seed-beds, first sprinkling the bundles with paris-green water. The young larvae will feed on these and be killed off before the seedlings come up.

(2) Crows, mynas, starlings, the cattle egret, and many other nesting birds all eat the grubs whenever they can find them, and they are particularly active in this respect in damp weather and after irrigation. Thus, whenever possible, the beds attacked by the pest should be flooded with water in the daytime. The water will fill the tunnels and force out the insects, which, if birds are

plentiful, will be picked up and eaten by them. If birds are not numerous hand-picking must be resorted to.

(3) Another good method of checking the pest is to dust the plants over a few times in the evening with a mixture of quicklime and ashes, or better still, add the arsenic compound paris-green to the two in the following proportion: One ounce of paris-green with one ounce of unslaked lime and 3 lb. of ashes. Powder the substances together very finely, put them into a calico bag, and dust over the plants, loosening the soil around them first.

(4) In nursery beds already attacked the surface of the soil should be carefully inspected, and all holes containing portions of leaves, stalks, etc., should be dug up and the larvae at the bottom killed. This was the method resorted to at Gora Gali by Mr. B. O. Coventry, and gave good results.

(5) Water the beds with a solution of copper sulphate. This penetrates to the roots and often kills the grubs.

It should be borne in mind, however, that our efforts should be in the direction of preventing the attack commencing, or at any rate from becoming serious. With this object numbers (1) and (3) of the above remedies are recommended. The former would be well understood, since the practice of poisoning jackals and porcupines is a very common one amongst the natives of India.

EUCHIRUS.

Euchirus macleayi, Ho.

REFERENCE.—Ho. *Ann. Nat. Hist.* iv, p. 300 (140).

Habitat.—Naini Tal, Eastern Himalaya, and Assam.

Tree Attacked.—Oak (*Quercus* sp ?). Naini Tal (R. C. Thompson).

Beetle.—Large, easily recognized by the enormously prolonged anterior legs of the male, several inches in length and spined. Head and prothorax green, shining; elytra black mottled with brown, red, or orange spots and markings. Head small, front concave. Prothorax convex with a deep longitudinal median depression, broadest posteriorly; widest in posterior third; sides rounded, with serrate edges; densely punctate save for shining areas on disk. Elytra smooth, pygidium and under-surface densely clothed with a very long whitish or yellowish pubescence forming a thick wool. Tibiae of all legs heavily spined. The long legs in the ♂ may be 3½ in. in length, very thick, with long tibiae and tarsi. Length (without legs), 50 mm. to 75 mm.

Description.

Life History.

This insect is commonly supposed to be chiefly found in the Eastern Himalaya and Assam. Thompson, in his *Report on Destructive Insects*, has the following note on *Euchirus*, and shows a photograph of the beetle in question, which would

seem to preclude the possibility of a doubt that the insect was taken at Naini Tal :—

> "Of the *Euchirus* figured I am not able to report from personal experience of its habits, but I have been informed on good authority that its habits are similar to its congener the Stag Beetle or *Lucanus cervus* (*L. lunifer*). The present specimen of the *Euchirus* was obtained at Nynee Tal, where it had issued out of an oak stem."

This is the only record I can find on the subject of this insect infesting this tree. The oak would probably be either *Quercus incana* or *Q. dilatata*.

FIG. 47.—*Euchirus macleayi*, Ho. ♂

FIG. 48.—*Euchirus macleayi*, Ho. ♀

RUTELINAE.

The beetles of this sub-family greatly resemble the last. Some are dull-coloured, but others are more brilliant, and greens and blues are obtained as well as browns. The claws of the tarsi differ in size.

Anomala.

Anomala grandis, Fabr.

References.—Fabr. *Syst. Ent.* p. 34; Burm. *Handb.* iv, 1, p. 275; *viridis, Ind. Mus. Notes,* ii, 39, 1891.

Habitat.—Darjeeling Forests.

Tree Attacked.—Utis (*Alnus nepalensis*). Darjeeling (C. G. Rogers).

Description.

Beetle.—Large, bright green, shining; under-surface brilliant coppery with a greenish reflexion; eyes yellow, antennae coppery, legs coppery or greenish coppery. Head small, finely punctate, eyes yellow, front rugose. Prothorax narrow in front, widest behind, finely punctate. Scutellum large, anterior edge truncate. Elytra truncate, finely punctate with a raised blunt point or tooth medianly at a short distance from apex; pygidium finely, irregularly, and transversely rugose-striate. Under-surface punctate. Length, 22 mm. to 30 mm.

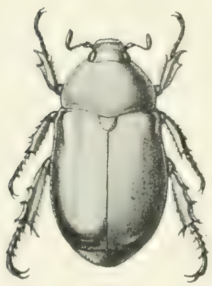


Fig. 49.—*Anomala grandis*, Fabr. Darjeeling.

Life History.

This beetle was forwarded some years ago to the Indian Museum, Calcutta, by Mr. C. G. Rogers. Mr. Rogers stated that he took the beetle stripping the leaves from the utis-tree (*Alnus nepalensis*) in June at elevations of 5,000 ft. to 6,000 ft. in the Darjeeling forests. Nothing further appears to have been recorded on the subject of the life history of this insect.

Adoretus.

Adoretus caliginosus, Burm.

Reference.—Burm. *Handb.* iv, 1, p. 471.

Habitat.—Gorakhpur, United Provinces.

Tree Attacked.—Sissu (*Dalbergia sissoo*). Gorakhpur (A. E. Osmaston).

Description.

Beetle.—Elongate, small, yellow, the elytra lighter-coloured than thorax. Head black, shining, densely punctate, covered with a short white villosity; eyes large, placed at sides at base. Prothorax wider than long, sides rounded; finely and densely punctate, and covered with the short white pubescence. Scutellum large. Elytra wider than thorax, widest in apical third, thence constricted and conjointly rounded. Moderately strongly punctate, and weakly striate; the tibiae strongly spined. Length, 9.1 mm.

Life History.

This beetle was taken by Mr. A. E. Osmaston, I.F.S., on the sissu at Pakri in the Gorakhpur Division. He found the insect in numbers defoliating the trees in the first half of May, both old trees and saplings suffering from the attack of the beetles. No further observations on its life history appear to have been recorded.

Fig. 50.—*Adoretus caliginosus*, Burm. Gorakhpur.

Adoretus caliginosus, Burm. var. **bicolor**, Brenske.

This variety has the head wholly fuscous and the pygidium slightly pubescent.

The insect is said to be widely distributed throughout India. It was reported as defoliating rose-bushes in the Botanical Gardens, Bangalore, in company with *A. bangalorensis.*

Adoretus bangalorensis, Brenske.

REFERENCE.—Brenske, *Ind. Mus. Notes*, v, 38.

Habitat.—Bangalore.

Tree Attacked.—Rose-bushes.

Beetle.—Head large, brown, slightly metallic; clypeus round, front small; posterior angles of prothorax rounded; elytral costae fine, uniformly pubescent; tarsi small, the joints close together; pygidium densely pubescent, apex slightly black.

This beetle has been reported as defoliating rose-bushes in the Botanical Gardens at Bangalore.

Adoretus cardoni, Brenske.

This insect (Brenske, described in *Ann. Soc. Ent. Belg.* vol. xxxii, 1893) has been reported as defoliating roses, cannas, etc., in Calcutta.

DYNASTINAE.

The forest species at present known as important are large bulky insects, the males furnished with a horn on the head and a prominent projection on the prothorax. The colour is most usually black, but sometimes the insects are brownish.

The grubs are large, thick, soft, and much curved, the posterior part of the body being swollen and bag-like. They commit damage to trees, more especially to the roots of young seedlings.

ORYCTES.

Oryctes rhinoceros, Linn.

(The Rhinoceros Beetle.)

REFERENCES.—Linn, *Syst. Nat.* ed. 10, 346 (1758). Stebbing, *Depart. Notes*, i, [illegible]

Habitat.—Throughout the plains of India.

Tree Attacked.—Casuarina (*Casuarina equisetifolia*); *Pithecolobium dulce*. Madras Plantations. Also palms of various kinds throughout the country.

Beetle.—Black, shining, massive, and large, with a prominent horn which curves backwards on the head, from which it gets its name of rhinoceros beetle. The elytra are very convex above, the insect being flat beneath. Shanks (tibiae) of legs armed with spikes, the front ones having each three spikes on their outer edges. A large roughly heart-shaped depression on front portion of thorax. A series of broad striae and punctures on elytra. Dark rufous beneath, with hair of same colour in parts. The beetle is easily recognizable by its form, by its antennae ending in a series of terminal plates, by its spiked tibiae and five-jointed tarsi, and by its great size. Length, 43 mm. Breadth across elytra, 18 mm.

Description.

Larva.—A large, stout, curved grub. Head flat, purplish-brown. Mandibles brownish to black, large, and stout; antennae five-jointed, basal joint enlarged. On first three segments behind head are three pairs of light-brown, stout, long, three-jointed legs. Body yellowish white, last two segments blackish. The head is smaller in transverse diameter than the rest of the body. Body is very thick, corrugated, curved, and swollen out so as to be almost bag-shaped behind. On each side of the third to tenth segments is a large dark-brown spiracle. Body above and below is thickly covered with brown spiky hairs except on last segment, where they are small and scattered. Length, taken round curve, 96 mm. Breadth, 18 mm.

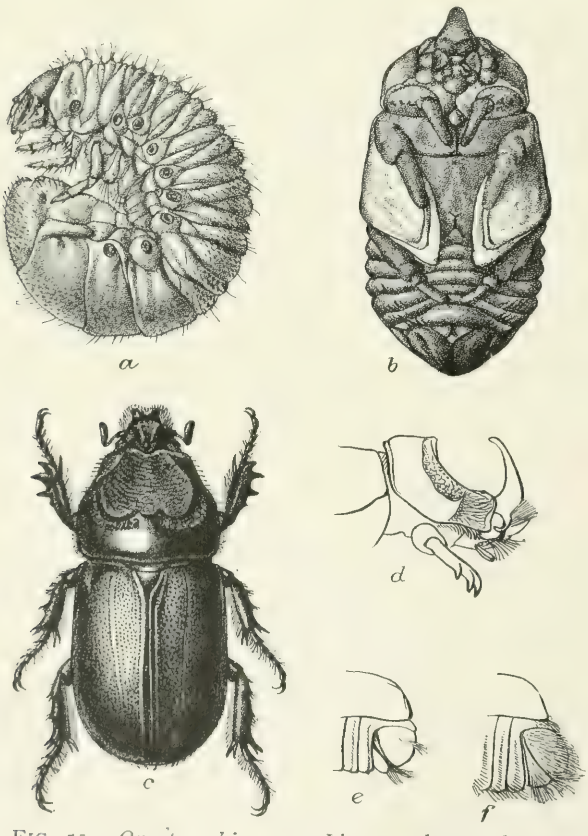


FIG. 51.—*Oryctes rhinoceros*, Linn. *a*, larva; *b*, pupa; *c*, imago (male); *d*, lateral aspect of head and thorax; *e*, end of body of male; *f*, end of body of female. (After Arrow in *F. B. I.*)

Life History.

The beetle is to be found on the wing during the greater part of the year. It may hibernate either as a larva or pupa, or perhaps beetle, from November to about March, remains in the soil through the winter in the resting stage, and appears first on the wing towards the end of March, remaining as late as the beginning of November. The adult insect spends some time in this state, and apparently can do with little food in this stage of its existence, as beetles have been kept alive for over two weeks without food of any kind.

The insect lays its eggs in the soil or in masses of palm and other refuse situated in or near palm topes. The grubs on hatching out feed in the decaying trees or in adjacent refuse-heaps, and evidently also con-

sume the roots of seedling plants. Mr. C. B. Dawson, District Forest Officer, Kistna, reports that the large grubs feed upon young casuarina seedlings, being attracted to them owing to the moisture in the sand in which they are planted. These young seedlings are watered whilst in the nurseries, and thus the moist layer of sand filled with the young roots would quickly attract grubs of this kind. It is not known whether the beetles lay their eggs in the nurseries, but as the eggs are laid in the soil as well as in the refuse-heaps in the palm topes it is not improbable.

In some parts of the country the beetle appears as early as March, and may even leave the soil in the latter part of October. Larvae are also to be found at other times in Madras.

Ranger P. V. Modiliar, in charge of the Coast Range, Nellore Division, took a number of the grubs, some full-grown, others partly grown only. They were feeding on the roots of young casuarina and *Pithecolobium dulce* in the plantations. The grubs cut through the roots just below the surface level, thus killing the young plants.

The grubs are also present in older plantations.

The beetle is a serious pest in palm topes. It bores into the soft parenchyma of the top of the growing shoot of the trees, burrowing downwards through the folded leaves, which on opening out show tattered holes where the beetle has pierced them in tunnelling. In this way the bud is often killed and the palm dies.

Protection and Remedies.

The following are remedies which have been already recommended for trial :—

1. Employ boys or women to remove carefully the soil round seedlings which are seen to be wilting, and take out and kill the fat grubs found at the roots. This should be done when seedlings are seen to be dying off in any considerable number, even at the expense of killing adjacent young plants by thus disturbing their root system. The grubs move from one plant to another, and one grub may thus destroy a number of seedlings.

2. If feasible, a simple and effective plan is to flood the plantation for a few hours so as to drown all the grubs in the soil. Those that come up to the surface should be collected and killed.

3. Remove all diseased, dead, and decaying date and coco-nut palms in the vicinity of nurseries and young plantations. Also—and this is an important point—all refuse-heaps of rotting vegetation, etc. If, in the formation of the nursery, special soil-pits of manure, litter, and leaves are prepared, they should be carefully inspected for these grubs, as the beetles will be certain to lay in such places. A good instance of this kind of danger was noticed in a Calcutta garden in June 1903. The heap of rich soil and humus used for manuring the flower-beds contained numbers of the larvae of this insect which were spreading from them into the beds of young seedlings, whose roots they were devouring. There were palm-trees close by.

XYLOTRUPES.

Xylotrupes gideon, Linn.

[illegible]

Habitat.—Burma, Assam.

Tree Attacked.—*Poinciana regia*, Pyinmana, Upper Burma (C. B. Smales).

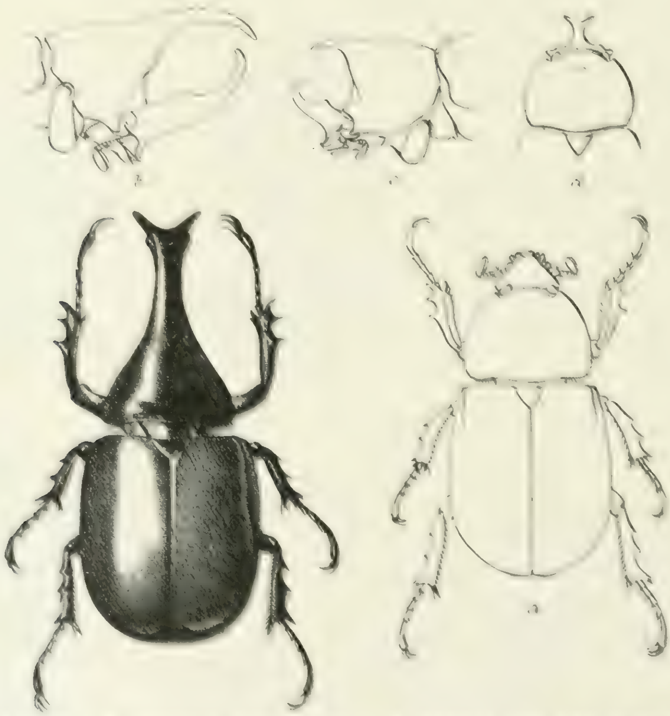


FIG. 50.—Xylotrupes gideon, Linn. ♂, natural size, with outline of female (a), and outlines of anterior part of males of maximum (b), intermediate (c), and minimum (d) development. (After [illegible].)

Beetle.—Shining black or brownish, massive, the elytra occasionally lighter-coloured; under-surface of [illegible] and metathorax, especially the two latter, clothed with a long coarse reddish pubescence. Abdomen and under-surface of two hind pairs of legs shining brown. ♂ easily distinguished by a long bifurcate horn projecting from the vertex of head, which curves upwards and backwards towards a thick bifurcate horn on the prothorax, which curves downwards and varies in length, at times being much longer than the one on the head.

Description.

In the ♀ the horn on the head is longer than that on the prothorax, the latter being sometimes a mere blunt knob. Length, 30 mm. to 60 mm.

Portions of stems of [illegible] seedlings girdled by [illegible]
Pyinmana, Upper Burma.

Life History. This insect, both male and female, was taken by Mr. C. B. Smales, I.F.S., in Pyinmana in Upper Burma. The beetles were found girdling young seedlings of *Poinciana regia* in a nursery, thus killing them. The plate shows portions of the stems of these young trees completely girdled by the beetles.

CETONIINAE.

Rather flat beetles, often of brilliant coloration, and not of particularly large size. The colour may be brilliant green or blue or brown, with white or yellow markings and spots. The sexes are similar to one another, the male being without protuberances on the head or thorax. The beetles are many of them diurnal, flying about in the sunlight, and being found on leaves and flowers in the daytime. They are commonly known as the rosechafers. It is in this sub-family that the elytra are joined down the middle suture, and so are elevated as one piece to permit the lower wings to be spread for flight.

TRIGONOPHORUS.

Trigonophorus hookeri, White.

REFERENCE.—White, *Proc. Zool. Soc.* p. 14, t. 41, f. 1 ♂; 2 ♀ (1856).

Habitat.—Assam Duars.

Tree Attacked.—Khair (*Acacia catechu*). Assam.

Description. **Beetle.**—Shining green or blue, tibiae and tarsi brown, latter darker. Head small, a small depressed bifurcate horn on vertex and another smaller horizontal bifurcate horn on front. Prothorax much wider than head, widest behind, finely punctate. Scutellum very large, triangular. Elytra widest at base, constricted behind humeral angles, apex rounded, pygidium exposed, finely punctate. Under-surface shining, smooth. Length, 20 mm. to 25 mm.

FIG. 53.—*Trigonophorus hookeri*, White. Assam Duars.

Life History. I took this insect very plentifully towards the end of May 1906 in areas adjacent to and between the Sunkos and Reidak rivers near their debouchment from the Bhutan Hills. The beetles were engaged in defoliating the khair, many of the trees being loaded with insects, whilst others were entirely leafless.

I do not know on what the larva feeds.

OXYCETONIA.

Oxycetonia versicolor, Fabr.

REFERENCE.—Fabr. *Syst. Ent.* 1775, p. 51; Schaum. *Ann. Soc. Ent. Fr.* 1849, p. 264.

Habitat.—Dehra Dun. Common in the plains.

Tree Attacked.—Rose-bushes.

Beetle.—Shining, small, reddish coppery; margins of thorax, elytra, also along the suture of the elytra, green; dorsal surface of the insect covered with small white spots, being especially numerous on the elytra. Length, 18 mm.

FIG. 54.—*Oxycetonia versicolor*, var. a. (From *F. B. I.*)

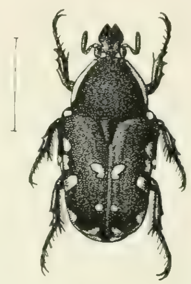


FIG. 55.—*Oxycetonia versicolor*, var. d. (From *F. B. I.*)

Life History. Not very much appears to be known about the life history of this insect. The beetle is very common in July and August in Dehra Dun, when it feeds upon the petals of roses and occasionally the *Hibiscus*.

OREODERUS.

Oreoderus gravis, Arr.

REFERENCE.—Arr. *Faun. Br. Ind. Lamell.* i, p. 288.

Habitat.—South Coimbatore, Madras.

Trees Attacked.—Bamboos (*Dendrocalamus strictus* and *Bambusa arundinacea*). Mount Stuart, South Coimbatore.

FIG. 56.
Oreoderus gravis, Arr.
South Coimbatore.

Description. **Beetle.**—A small bulky weevil. Black, corrugated and crinkled, the elytra flat on disk. Head concealed beneath the deeply channelled and coarsely rugose prothorax; latter broadest behind the basal margin medianly produced. Elytra much broader than prothorax, flat on top, vertically depressed downwards laterally; apex truncate, leaving exposed a short broad pygidium; depressed and rugulose in middle, elevated laterally into a prominent ridge which is prolonged into a short tooth at apex. Pygidium and undersurface black, the body thick, legs rather elongate and slender, the anterior tibiae with two large teeth on outer edge. Length, 9 mm.

I took a specimen of this weevil on a thicket of young bamboos at the end of August 1902 at Mount Stuart in South Coimbatore. It is the only individual of the species I have taken.

CHAPTER VII.

ADEPHAGA.

TARSUS of all legs five-jointed. Joints of antennae simple. Larva with two-jointed tarsi.

Family CICINDELIDAE.

(*Tiger Beetles.*)

FIG. 57.—*Cicindela sexpunctata.*

Beetle.

This is a family of predaceous beetles provided with powerful curved mandibles and long legs adapted for rapid running movements. The tiger beetles are easily recognizable from their general shape and the fact that the clypeus stretches laterally in front of the insertion of the antennae, whilst the maxillae end in an articulated joint. The insects are often brilliantly coloured, either uniformly throughout or with bands and spots on them—greens, blues, browns, or blacks predominating, with white, yellow, red, or other coloured spots. The elytra are broader at the base than the prothorax, having shoulders to them, and are smooth. The beetles are never very large, half an inch to a little over an inch usually. Some forms are wingless.

Larva.

The larva is a curious whitish elongate grub, with a largely developed head armed with stout curved mandibles, an enlarged prothoracic segment, the remaining segments and those of the abdomen being of much less width. The seventh segment counting from the head is furnished dorsally with a curious projecting hump. There are three pairs of legs on the thoracic segments.

FIG. 58.—*Cicindela octonotata*, Wied. Assam.

The members of the family as a whole feed upon insects of all kinds, and many are diurnal, flying or running rapidly about in the sunlight.

The importance of the tiger beetles in the forests has yet to be definitely decided. Blue forms of the genus *Collyris* are often to be found on the bark of trees, and not improbably may be found to prey upon wood- and bark-boring beetles. This point has yet to be established, as also where the larvae of the forest-living forms dwell.

The larvae of the members of the family which live in the open country usually construct vertical

tunnels in wet sand or soil near rivers and streams, and live in these, preying upon such insects as come near them.

The bright-coloured insect *Cicindela octonotata*, Wied., is common on the stony river-beds and banks of the Sunkos, Reidak, and other rivers in Assam, where I have taken it in numbers in the latter part of May. *C. sexpunctata* is a common little cicindelid found in the rice fields and often on the borders of the forest.

Family CARABIDAE.

(*Ground Beetles.*)

Beetle.

The Carabidae are a predaceous family of beetles closely allied to the Cicindelidae, and having the long curved biting mandibles of the latter, from which they may be distinguished by the fact that the clypeus does not stretch laterally in front of the insertion of the antennae and the maxillae are not hooked. The tarsi are five-jointed and the antennae are filiform, and thus the insects can be distinguished from the Tenebrionidae (p. 232), which in their dark colouring and shape they otherwise to some extent resemble. The beetle is compact in form, with close-fitting elytra, often more oval than in the cicindelids. The elytra are occasionally, as in tenebrionids, soldered together, with no wings for flight below. In many forms the legs are long and adapted for running, in others short and fitted for digging. The colours are usually dull black, brown, or greyish, with occasionally spots of yellow or white.

Larva.

Little is known about the larvae of the family. They are supposed to be uniformly predaceous, furnished with a large head and powerful mandibles, the rest of the grub tapering posteriorly, dull brown or black in colour, the last segment ending in a pair of cerci; three pairs of walking legs are present on the thoracic segments.

The habits of some of the beetles are known, the insects preying upon other insect life either during the daytime or at night. Some forms have been found under the bark of trees feeding upon bark- and wood-boring beetles, etc., and the whole life of these species may be passed within the tree. Others have been found in the soil.

Fig. 59.—*Calosoma orientale*, Hope. N. India.

Calosoma orientale, Hope.

Reference.—Hope, *Trans. Zool. Soc.* i, p. 92.

Habitat.—Peshawar and elsewhere in Northern India.

Habits.—This carabid has been reported to prey upon the young of the locust *Schistocera peregrina*.

Anthia sexguttata, Fabr.

REFERENCE.—Fabr. *Syst. Ent.* p. 136.

Habitat.—Changa Manga, Punjab; Berar. Common in the plains of North and Central India.

Habits.—In Berar in July 1901 I found this large carabid attacking the caterpillars of the large hawk-moth (*Pseudosphinx discistriga*), which happened to be very abundant defoliating the leaves of the teak-trees in the Melghat Forest. The beetle itself was in some numbers, running up the main trunks and on to the branches of the trees, and there could be no doubt of its carnivorous activities at the time I observed it. I have never since found it preying upon caterpillars.

At the Changa Manga Plantation near Lahore in the Punjab I took the insect feeding upon the wood-borer *Sinoxylon anale*, and think it was also attacking the species of *Alindria* and *Melambia* which were themselves preying upon the *Sinoxylon*. I took several specimens of the carabid at various heights on a large standing sissu-tree, and saw others right up the bole just beneath where the crown commenced. This tree was very badly attacked by the *Sinoxylon*, which was tunnelling into it to oviposit. The carabid was searching for the beetles which had partially disappeared into the bark, seizing such when found and dragging them from their partly formed holes and devouring them (*vide* p. 173).

Macrochilus bensoni, Hope.

Habitat.—United Provinces Terai, North India.

Habits.—This is a common carabid, appearing in numbers at the commencement of and throughout the rains in North India. I took pupae and beetles, some of the latter mature, in the soil at the foot of sál-trees in the Horai forests of the Kumaun Division on 11 May 1908. The insects were predaceous upon the larvae of the cockchafer beetles *Lachnosterna problematica*, *L. clypealis*, and *Heteroplia varians* (p. 79).

I have also taken specimens of this insect or a closely allied species from beneath the bark of a dead stump of a *Homalium tomentosum* tree on the Salween River in Tenasserim.

The insect was active and numerous in the stump on 8 March 1905, and was feeding upon a termite which was riddling the wood.

Scarites bengalensis, Dej.

REFERENCE.—Dej. *Spec.* ii, p. [illegible].

Habitat.—Changa Manga, Punjab.

Habits.—This beetle is predaceous upon the sissu wood-borer *Sinoxylon anale*. It was taken from beneath the bark of a sissu-tree badly infested by

the *Sinoxylon* in company with species of *Alindria* (p. 114) and the carabid *Morio subconvexus*. I have not taken the larvae of the beetle. It is probable that they also live beneath the bark of the tree, and possibly enter the tunnels of the bostrychids and prey upon the larvae of the latter (p. 174).

FIG. 60.—*Scarites bengalensis*, Dej. Changa Manga.

Morio subconvexus, Chand.

Habitat.—Changa Manga, Punjab.

Habits.—The beetle preys upon the bostrychid wood-borer *Sinoxylon anale*. I took the insect in company with other predaceous beetles beneath the bark of a large sissoo-tree badly attacked by the *Sinoxylon*. I have not taken the larvae, but imagine that they will be found in the burrows of the bostrychid larvae (p. 174).

Amblystomus magnus, Bates.

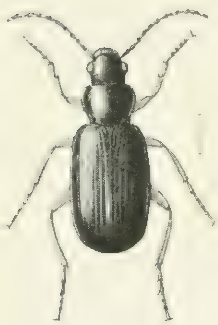


FIG. 61.—*Amblystomus magnus*, Bates. Katha.

Habitat.—Katha, Upper Burma.

Tree Infested.—Teak (*Tectona grandis*). Mohnyin Forest, Katha, Upper Burma.

Beetle.—Small black, very shining, with a striped pygidium. Legs and antennae brown. Head and thorax very finely punctate. Elytra striate, the intervals smooth. Length, 5 mm.

I took a specimen of this carabid from beneath the bark of a large girdled standing teak-tree in the Kadu depot in the Mohnyin Forest up in Katha. It is the only specimen of the insect I have taken.

Tachyta nietneri, Schaum.

REFERENCE.—Schaum. *Berl. Zeit.* p. 88 (1863).

Habitat.—Tons Valley, 2,300 ft., North-West Himalaya; Tharrawaddy, Lower Burma.

Trees Infested.—Chir Pine (*Pinus longifolia*): Thadiar, Tons Valley; *Anogeissus latifolia*: Konbilin Forest, Tharrawaddy, Lower Burma.

FIG. 62.—*Tachyta nietneri*, Schaum. N.W. Himalaya; Burma.

Beetle.—Very small, dark brown, shining; head triangular, with long curved black mandibles. Thorax smooth, with a longitudinal medium impression. Elytra smooth, finely striate. Legs and antennae brown. Length, 2 mm. to 2.2 mm.

Larva.—Twelve segments, yellow in colour except first, which is brown, and the anterior portion of second, which is yellowish brown. Head square, large, black, provided with a pair of stout calliper-

like mandibles. Thoracic segments with three pairs of legs. Posterior segment terminates in two corneous processes, calliper-shaped, the under-surface of segment forming a kind of pseudo-pod. Length, 5 mm.

Life History.

I first took specimens of this very active beetle from beneath the bark of a dying chir-pine log in the Tons Valley. The insect was found in large numbers in the tunnels and galleries, and appeared to be predaceous upon the wood- and bark-infesting insects of this tree. These specimens were taken on 8 June 1902. The tree was attacked by the *Tomicus* and *Polygraphus* bark-borers and the *Platypus* wood-borer. The larvae of the carabid were also numerous. They are rapid walkers, using the thoracic legs and the pseudo-pod. Their jaws are extremely powerful, and they are very tenacious of their grip once having got a firm purchase. When they had seized a piece of stick with which I poked them about I could lift them clean up by their jaws, as they refused to let go (pp. 527, 561).

On 22 January 1905, in Burma, I again took specimens of a minute carabid, which has been identified as this species of *Tachyta*, from beneath the bark of a large felled *Anogeissus latifolia* tree. This tree had been cut down in a tounggya clearing in the Kadin Bilin Forest in Tharrawaddy. I again on this occasion recorded a note to the effect that the insect was exceedingly active and appeared to be carnivorous. Here it probably attacks the *Platypus rectangulatus* (p. 623) of the *Anogeissus* and other bark-borers.

Omphra ? sp.

Habitat.—North-West Himalaya.

Habits.—This carabid is predaceous upon the caterpillars of the deodar geometer moth. These "looper" caterpillars seriously defoliate the deodar in parts of the North-West Himalaya in June–July, sometimes entirely stripping all the needles from the trees. In July 1901 Mr. E. M. Coventry, of the Indian Forest Service, found this carabid feeding upon the caterpillars in the Kalela Forest of the Simla Division. The greater part of this forest was entirely defoliated that year.

CHAPTER VIII.

POLYMORPHA.

TARSUS of legs variable. Joints of antennae clubbed or serrate.

Family HYDROPHILIDAE.

The family may be recognized by the curious antenna, which consists of a long basal joint, the rest of the joints, except from one to three very short ones, forming a club of which the apical ones are widened out and pubescent. The beetles are shining black or dull in colour, the head, prothorax, and elytra fitting closely together, as shown in fig. 63. They are of small size. The family consists principally of aquatic forms. One forest-living beetle, a species of *Régimbartia*, is described briefly below, but I have not taken its larva.

Régimbartia aenea, Benth.

FIG. 63.—*Régimbartia aenea*, Benth. Assam.

Habitat.—Goalpara, Assam.

Tree Infested.—Sál (*Shorea robusta*). Kachugaon, Goalpara.

Beetle.—Elongate-ovate. Black, with a shining yellowish lustre. Head depressed, impressed medianly ; the eyes large, placed laterally, and yellowish in colour. Prothorax convex, depressed in front, wider than long, anterior margin and sides rounded ; disk smooth and very finely punctate. Scutellum elongate, heart-shaped, very finely punctate. Elytra elongate, very convex, depressed apically, the sides rounded to posterior coxae, and thence rather sharply constricted ; apices separately rounded ; very finely punctate. Under-surface dull black. Legs shining black. Length, 5 mm.

Description.

Life History.

This beetle in its mature state is probably a sap-feeder. During a visit to the Kachugaon sál forests in Assam in May 1906 Mr. Perrée had a large green healthy sál-tree felled for me on the 13th. Between the 16th and 19th of the month this beetle was found beneath the bark of this tree

in the cambium layer, which was full of sap, upon which it appeared to be feeding. The tree was visited on the 14th and 15th, and portions of the bark stripped off, but the insect was not observed in it before the 16th. It had apparently been attracted to the tree by the presence of the oozing sap.

Family SILPHIDAE.

Present investigation has not shown this family of beetles to be of importance in the forest. It is chiefly of interest owing to the habit of some members termed "burying" beetles. These insects bury the bodies of small mammals by removing the soil below the bodies so as to cause them to sink into the ground; the beetles then feed and oviposit in the decomposing mass, in which their grubs are also reared. This habit has not yet been observed in the case of the Indian forest species, whose life histories are little known.

The beetles of the family vary in shape and appearance, and may be recognized by having the conical-shaped coxae of the front legs placed close together, the antennae being usually clubbed. They are supposed to be similar in habits to the Staphylinidae, and some may be predaceous.

A common Indian species is *Silpha tetraspilota*, a squarish, flat beetle, with a broad prothorax, and broad elytra marked with a few prominent longitudinal ridges.

Family STAPHYLINIDAE.

(*Rove Beetles.*)

The beetles are easily recognized by the short truncate elytra which only cover the base of the abdomen, and leave exposed this latter, which is more or less long and flexible. The under-wings are folded up and tucked away under these short elytra. The shape varies from elongate and narrow to oval or elongate-oval forms, shining-black or brown or dull yellow-brown in colour. The elongate forms have a superficial resemblance to earwigs (Forficulidae), from which they must be distinguished. The legs are short, and have a tarsus with a variable number of joints. The beetles run rapidly, and have the power of curling up the abdominal segments over the back. The mouth is usually provided with stout mandibles, which are often specially prominent in the larval forms which live under the bark of trees. In other respects the larvae often resemble in form the beetles, save that the wings are absent.

The beetles and larvae of the forest forms of this family are in many cases predaceous, feeding upon bark- and wood-boring insects, or on species

which live under the bark of trees, feeding upon the sap or decaying matter. It is probable that some of the staphylinids found in trees also feed chiefly on decaying matter. The few species I have been able to observe appeared, however, to be predaceous in character.

FIG. 64.—*Staphylina* in blue pine. × 6. N.W. Himalaya.

Many of the forms living under the bark of trees have a general resemblance either to the common staphylinid found in country lanes in England, the "devil's coach-horse," or to some of the commoner histerids found beneath the bark of trees. Species of both these types are to be found in coniferous trees preying upon scolytid larvae in the Western Himalaya; whilst a third, resembling the histerid type, but with a more elongate abdomen, giving the insect a torpedo-shaped appearance, is to be found beneath the bark of trees.

Amongst the trees from which I have taken these small forms of staphylinid beetles may be mentioned the deodar, blue pine, spruce, long-leaved pine, and the *Quercus incana*, in the Western Himalaya; *Bambusa polymorpha*, *Milletia brandisiana*, *Garruga pinnata*, and pyinkadu, in Tharrawaddy; teak, *Morus laevigata*, *Schima noronhae*, and *Eugenia grandis*, in Katha in Upper Burma; *Homalium tomentosum* and *Miluisa velutina* in Tenasserim; in Assam, *Ficus elastica*, various species of trees in the Evergreen Forests in North Darrang, *Pinus khasya* in Shillong, and sál in Goalpara; and in the sál in the Mandla forests in the Central Provinces, where the staphylinid appeared to be feeding upon the wood-borer *Sinoxylon crassum*, and perhaps on *Hectarthrum heros*, which is predaceous upon the borer here.

Holosus ? sp.

Habitat.—North-West Himalaya.

Habits.—This small, elongate, shining-black staphylinid is predaceous upon the smaller bark-boring scolytids of the blue-pine in Jaunsar. It attacks *Polygraphus pini*, Stebbing, *Crypturgus pusillus*, and, I think, *Pityogenes coniferae*, Stebbing, and possibly the grubs of *Tomicus ribbentropi*, Stebbing. I have also taken it from spruce and deodar.

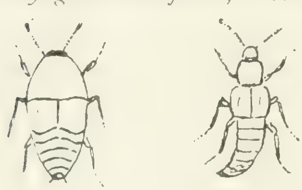


FIG. 65. *Leucocraspedum* ? sp. N.W. Himalaya. *Holosus* ? sp. (E.P.S.)

Leucocraspedum ? sp.

Habitat.—North-West Himalaya.

Habits.—This small, oval, elongate, black, shining staphylinid is found fairly commonly in felled and girdled blue-pine infested with the

Polygraphus pini and *Crypturgus pusillus* beetles in Jaunsar. The beetle has a superficial resemblance to a histerid (*Paromalus*, etc.). The insect is predaceous, feeding on the scolytid grubs and perhaps on the pupae. I have also taken it from spruce.

Family HISTERIDAE.

Beetle.

The forest histerids are for the most part easily recognizable beetles, being short, hard, and compact, the parts fitting accurately together; usually black, occasionally brown, in colour, and shining; but some considerable metallic colouring occurs in the family. The elytra fit very closely together, are very hard, with their apices usually truncate, leaving exposed two segments of the abdomen; the prothorax is often incised on the anterior edge, the head fitting into the incision; in some divisions of the family the head is retractile; the antennae are elbowed, eleven-jointed, the basal joint being long and the terminal three forming a club.

The beetles vary in shape, some of the bark-living forms being thin, flat, and squarish, whilst others are compact cylinders, resembling in section the bark- and wood-borers upon which they prey. The legs are short, the tibiae often flattened and spined, and perhaps aid the beetle in making a way through tunnels and galleries filled with wood-dust. The mandibles are strong and powerful, and in some species long.

FIG. 66.—*Hololepta baulnyi*, Mars. Siwaliks.

Larva.

The type of *Niponius* larva is an elongate pinkish-yellow or whitish-yellow grub, with stout, well-developed mandibles, a pair of jointed processes or cerci to the end of the abdomen, a well-developed thoracic segment with a hard chitinous plate dorsally, followed by two narrow segments. The median abdominal segments are the broadest. The under-surface is usually paler than the upper, and often translucent. I have never actually reared either of the *Niponius* beetles described below from their grubs.

A smaller type of grub is that of the genus *Teretriosoma*, which has the abdominal segments narrower, the median ones not much broader than those anterior and posterior to them.

Pupa.

The *Niponius* pupa, which is the only one I know, is elongate, straight, and white, with a vertical head and free limbs, wings, etc. The *Niponius* egg is large, spherical, and pale translucent.

The histerid family is a most interesting one to the forester in India, owing to the fact that it contains a number of very important predators on

forest pests. As a whole the family are found either beneath the bark or wood of the stems, roots, or branches of trees, in decaying animal or vegetable matter, or in fungi "puff-balls." They are not for the most part diurnal insects, and therefore during the daytime they must be searched for in their homes. Some species are to be found under stones, logs, and other debris in the forest during the daytime. Here, however, we are more particularly concerned with the members of the family who live in and breed in the trees. Of their habits something has already been learnt, but much remains to be done in the study of their exceedingly interesting life histories. That some of the species whose habits have already been investigated are of the first importance in the forest, the life histories of the two species of *Niponius*, to mention but one genus, will show; and yet the first of these, *N. andrewesi*, of the plains forests, was described as a new species in 1893, the other, *N. canalicollis*, of the Himalayan coniferous areas, in 1901. In a previous chapter I have already dealt with the importance of these predaceous enemies of the bark- and wood-boring beetles.

Mr. G. Lewis, F.L.S., has suggested * that the striae on the elytra might be of use as guiding lines in the case of species such as *Niponius*, assisting them to follow wood-boring Platypi down their tunnels. My ten years' investigation work in various parts of India would seem to show that the genera *Niponius*, *Platysoma*, *Cylistosoma*, and *Paromalus* seek out the sub-cortical Scolytidae, such as *Scolytus*, *Tomicus*, *Polygraphus*, *Sphaerotrypes*, etc., obtaining access to the tree through the entrance bore-holes of the beetles, and crawling down these to reach the partially or fully formed egg-galleries in the bast layer. In the case of some genera, e.g. *Niponius*, the eggs are laid in these latter galleries.

Niponius.

This genus was founded on some Japanese species. The three Indian species known were described in 1893 (2) and 1901.

Niponius andrewesi, Lewis.

References.—Lewis, *Ent. Mag.* xxix, p. 183 (1893); *Ann. Nat. Hist.* xiv, p. 151, pl. 6, f. 3, 3*a* (1904)

Habitat.—United Provinces, Central Provinces, Assam, Madras. Also reported from Bombay Presidency.

Habits.—This insect (*vide* fig. 317) is predaceous upon all the species of *Sphaerotrypes* bark-borer of the sál-tree in India. The beetle is of cylindrical shape, of about the same diameter as the *Sphaerotrypes*, and enters their tunnels and oviposits in the egg-gallery of the bark-borer, two or three large, spherical, pale-whitish, translucent eggs being deposited. The grubs feed on the bark-borer grubs.

* *Ann. Mag. Nat. Hist.* June 1892; *Ent. Monthly Mag.* 2nd ser. 183 (1893).

I have taken this *Niponius* in the galleries of *Sphaerotrypes siwalikensis* in the sál in the Siwaliks and United Provinces Terai forests; in those of *Sphaerotrypes coimbatorensis* in *Anogeissus latifolia* in Coimbatore, in Madras; again in sál, attacking *S. assamensis*, in Assam, and *S. globulus* in sál in the Central Provinces.

Writing from a knowledge of the habits of this insect, but without having been able to verify my opinion, it will probably be found that in the Bombay Presidency this insect is present in *Anogeissus latifolia*, feeding predaceously on *S. globulus* in that tree (*vide* p. 480).

Niponius canalicollis, Lewis.

REFERENCES.—Lewis, *Ann. Nat. Hist.* viii, p. 370 (1901); Stebbing, *Depart. Notes*, p. 248, pl. 13, f. 6 (1903); Lewis, *Ann. Nat. Hist.* xiv, p. 151, pl. 6, f. 1 (1904).

Habitat.—North-West Himalaya; North Zhob, Baluchistan; Sulieman Mountains.

Habits.—Next to the clerid *Thanasimus himalayensis*, I look upon this *Niponius* (*vide* fig. 6) as the most important of the predaceous foes of the bark-boring beetles of the conifers of the North-West Himalaya, and the forests clothing the mountainous region in the North of Zhob and the Sulieman Mountains. The distribution of the insect, so far as my personal observations have gone, extends from Kumaun in the Himalaya on the east to the Sulieman Mountain Range on the extreme west. Within this area I have taken the insect in the *Pinus longifolia* in Kumaun, Jaunsar, Tehri Garhwal, Simla, Bashahr, and Chamba; in the deodar, blue pine, and spruce in Jaunsar, Tehri Garhwal, Simla, Bashahr, and Chamba; and in the *Pinus gerardiana* in the North Zhob and Sulieman Mountain forests.

Mr. G. Lewis suggests* that the Zhob Mountains are "probably the western geographical limit of *Niponius* as Japan is of its eastern boundary."

The insect feeds predaceously upon the following scolytid bark- and wood-borers:—

In Deodar: *Scolytus major, Scolytus minor.*

In Blue Pine: *Polygraphus major, Polygraphus pini, Tomicus ribbentropi.*

In Blue Pine and Spruce: *Hylastes himalayensis, Rhyncholus himalayensis.*

In Pinus longifolia: *Tomicus longifolia* (*vide* p. 507).

HOLOLEPTA.

Hololepta baunlyi, Mars.

REFERENCE.—Mars. *Mon.* p. [illegible], pl. [illegible], f. [illegible] ([illegible]).

Habitat.—Siwaliks, North India.

Habits.—Specimens of this histerid (fig. 66) were taken by Student B. C. S. Gupta, of the Imperial Forest School, Dehra Dun. He found them under the bark of a dead *Lagerströmia parviflora* tree at Bulawala, in the Dehra Dun, on 17 February 1902.

* *Ann. Mag. Nat. Hist.* ser. 7, vol. xix, April 1907.

FIG. 67.—*Hololepta indica*, Erichs. × 2. Siwaliks.

Hololepta indica, Erichs.

REFERENCES.—Erichs. *Jahrb.* p. 90 (1834); Mars. *Mon.* p. 152, pl. 4, f. 10 (1853); *batchiana*, Mars. l.c. p. 588, pl. 11, f. 2 (1860); Lew. *Ann. Mus. Genova*, xii, p. 631, (1891); *aequa*, Lew. *Ann. Nat. Hist.* xvi, p. 204 (1885).

Habitat.—Siwaliks, North India. Also reported from Assam, Java, New Guinea.

Habits.—This insect was taken by Student B. C. S. Gupta, at Bulawala, beneath the bark of *Lagerströmia parviflora* in company with *H. baunlyi*, as above described.

TERETRIOSOMA.

Of the three Indian species known, the first was described in 1870, the other two in 1901.

Teretriosoma intrusum, Mars.

REFERENCES.—Mars. *Ann. Soc. Ent. Belg.* (*Teretrius*) xiii, p. 121 (1870); Stebbing, *Depart. Notes*, p. 20 (1902).

Habitat.—Changa Manga, Punjab; Sukkur, Sind; Seoni, Central Provinces.

Habits.—This insect is predaceous upon the wood-boring beetles *Sinoxylon crassum* and *S. anale*. It has been taken in the galleries of the beetles in sissu wood at the Changa Manga Plantation; in *Prosopis spicigera* in Sukkur, Sind; and in *Terminalia tomentosa* at Seoni, in the Central Provinces (*vide* p. 164).

Teretriosoma stebbingi, Lewis.

REFERENCE.—Lewis, *Ann. Nat. Hist.* viii, p. 380 (1901); Stebbing, *Depart. Notes*, p. 19 (1902).

Habitat.—Changa Manga Plantation, Punjab.

Habits.—The insect has been taken in company with *T. intrusum*, predaceous upon the wood-borers *Sinoxylon crassum* and *S. anale*, in sissu wood at the Changa Manga Plantation (*vide* p. 164 and fig. 108).

Teretriosoma cristatum,* Lewis.

REFERENCES.—Lewis, *Ann. Nat. Hist.* viii, 381 (1901); Stebbing, *Depart. Notes*, p. 19 (1902).

Habitat.—Changa Manga Plantation, Punjab.

Habits.—Predaceous upon *Sinoxylon crassum* and *S. anale* in sissu-trees at the Changa Manga Plantation (p. 164).

TERETRIUS.

The only Indian species of the genus mentioned in Lewis' Catalogue* was taken at Seoni in the Central Provinces. A second species from the Punjab was described in 1911.

* According to Sharp (*Ent. Soc.* p. 513, 1912) *cristatum* is the female of *stebbingi*.

Teretrius indus, Lewis.

REFERENCE.—Lewis, *Ann. Nat. Hist.* x, p. 277 (1902).

Habitat.—Seoni, Central Provinces.

Habits.—I took specimens of this insect from the tunnels of *Sinoxylon crassum* in a *Terminalia tomentosa* post taken from the roof of a bungalow in Seoni, in the Central Provinces. The insect proved to be new to science, and this was the first discovery of the existence of the genus in India (*vide* p. 164 and fig. 108A).

Teretrius mogul, Lewis.

REFERENCE.—Lewis, *Ann. Nat. Hist.* ser. 8, viii, p. 78 (1911).

Habitat.—Changa Manga, Lahore, Punjab.

Habits.—I took this insect associated with *Teretriosoma intrusum* in the galleries of *S. crassum* in *Dalbergia sissoo* at Changa Manga, near Lahore (p. 164).

PLATYSOMA.

Platysoma rimarium, Er.

REFERENCES.—Erichs, *Jahrb.* p. 112 (1834); Mars. *Mon.* p. 149, pl. 3, f. 9 (1861).

Habitat.—Siwaliks, North India.

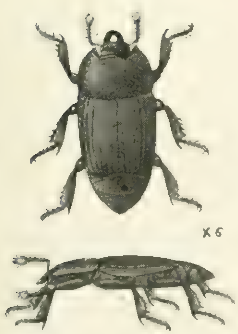


FIG. 68.
Platysoma rimarium, Er. Siwaliks.

Habits.—In January 1902 I took specimens of this histerid from beneath the bark of a dead felled sál-tree at Dholkhand, on the south side of the Siwaliks. The dead tree was infested by the beetles *Carpophilus flavipes* and *Ecnomaeus* (pp. 109, 110), and it is possible that the histerids may have been predaceous upon these latter.

Towards the end of February of the same year, Mr. A. Littlewood, of the Madras Provincial Service, at the time a student at the Imperial Forest School, took further specimens of the beetle from beneath patches of rotting bark on living sál-trees at Karwapani, in the Dun.

Platysoma rimae, Lewis.

REFERENCE.—Lewis, *Ann. Nat. Hist.* ser. 7, vol. xvi, p. 313 (1905).

Habitat.—North-West Himalaya.

Habits.—A common histerid, to be found in the galleries of many of the coniferous bark- and wood-borers in the Western Himalaya, upon which

* *A Systematic Catalogue of Histeridae.* G. Lewis, F.L.S. (1905).

it feeds. I have taken the beetle in the galleries of *Tomicus Ribbentropi* and *Rhyncholus* in blue pine, in those of the two *Scolyti* in deodar, and in *Rhyncholus* and *Hylastes himalayensis* galleries in the spruce (*vide* p. 576).

The insect may prove to consist of two distinct species. An insect taken from a *Tomicus* gallery is figured on p. 557 ; one taken from a *Scolytus* gallery on p. 576.

Platysoma ? sp.

Habitat.—North-West Himalaya.

Beetle.—Black, shining above and below ; very flat and somewhat elongate. Head with a stout pair of long mandibles. Length, 3.9 mm.

Habits.—I have taken specimens of this insect from beneath the bark of girdled dead *ban* oak (*Q. incana*). The insect is a carnivorous one, and probably predaceous upon some of the Coleoptera found beneath the bark of this tree (p. 545).

FIG. 69.—*Platysoma* sp. in *Quercus incana*. × 5. N.W. Himalaya.

Platysoma ? spp.

Habitat.—Assam.

Habits.—I took two histerids sparingly in the Kachugaon forests in Assam. They are predaceous upon *Sphaerotrypes assamensis*, Steb., and *Diapus furtivus*, sp. nov., Sampson (*vide* pp. 487 and 631).

CYLISTOSOMA.

Cylistosoma dufali, Mars.

REFERENCES.—Mars. *Abeille* (*Platysoma*), i, p. 310 (1864) ; *scitulum*, Lewis, *Ann. Nat. Hist.* iii, p. 280 (1889) ; Stebbing, *Depart. Notes* (*Platysoma*), 351 (1906).

Habitat.—North-West Himalaya.

Habits.—This histerid is predaceous upon *Tomicus ribbentropi*, and perhaps on *Polygraphus pini*, in blue pine (p. 556).

CARCINOPS.

Carcinops sp.

REFERENCE.—Determined by Mr. Lewis as an undescribed species of *Carcinops*.

Habitat.—North-West Himalaya.

Beetle.—Elongate, torpedo-shaped, and very flat ; reddish brown in colour, shining. Length, 2.3 mm.

Habits.—I took this histerid beneath the bark of a girdled *ban* oak-tree (*Q. incana*) at Kathian, in Jaunsar.

The insect was found in the same tree as the *Platysoma*, and is undoubtedly predaceous.

FIG. 70.—*Carcinops* sp. × 10. N.W. Himalaya.

Paromalus.

Paromalus sp. nov.

Reference.—Determined by Mr. Lewis as a new species of *Paromalus* at present undescribed.

Habitat.—North-West Himalaya.

Habits.—The insect is predaceous upon the conifer wood-borers *Rhyncholus himalayensis* and *Hylastes himalayensis* of the spruce and blue pine. This histerid is an active one, and is fairly common in the Western Himalaya (p. 453).

Paromalus sp.

Reference.—At present undescribed. May be identical with *Paromalus* sp. nov. above.

Habitat.—North-West Himalaya.

Habits.—I found this insect in numbers beneath the bark of newly felled and standing green *Pinus longifolia* trees at Jermola and elsewhere in Jaunsar and Tehri Garhwal in October 1906.

The histerid is predaceous upon the bark-borers *Tomicus longifolia* and *Polygraphus longifolia* (p. 560).

Family NITIDULIDAE.

This is a family of small beetles, of which some species are commonly met with in the forests beneath the bark of trees or feeding at the oozing sap of the newly cut surfaces of stumps.

Beetle.

The insects are of small size, flat, and brown or yellow-brown in colour. The antennae have a three-jointed club, all the coxae are separated, and each has an external prolongation; the tarsi are five-jointed, the fourth joint being the smallest; the abdomen with five visible ventral segments, and the elytra very often truncate. The beetles resemble some forms of Staphylinidae and Histeridae.

Larva.

The larva in some forms is elongate, slightly curved, with a well-marked head, dorsal shield to the prothorax, and three pairs of jointed legs on the thoracic segments; the body segments taper posteriorly.

As a family the insects feed, perhaps, chiefly on sap, but also on decaying vegetable and animal matter. The beetles are often found on or in flowers and in dried fruits or seeds. They are also commonly found in the tunnels of wood-borers in wood and bamboos, in the decaying fibres of bark, etc.

The common beetle *Carpophilus hemipterus* has been found in many situations, as will be described.

The family is probably of small economic importance in the forest.

Carpophilus.

Several minute species of the genus are commonly found in trees and bamboos in the forests.

Carpophilus hemipterus, Linn. var.

Reference.—Linn. *Syst. Nat.* i, 2, p. 565.

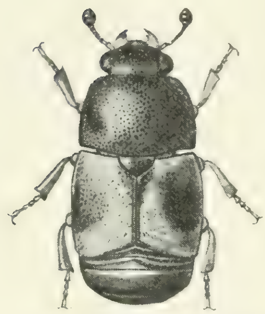


Fig. 71.—*Carpophilus hemipterus*, var. N. India and Central Provinces.

Habitat.—Dehra Dun and North India generally. Mandla, Central Provinces.

Trees Infested.—Bamboo (*Dendrocalamus strictus*), *Buchanania latifolia*: Dehra Dun; Sál (*Shorea robusta*): Mandla.

Beetle.—Small. Head black; prothorax and pygidium brownish black; elytra yellow with a brown patch in centre of each. Head and prothorax punctate. Scutellum large. Elytra short, leaving exposed several segments of body; finely punctate. Length, 4 mm.

Larva.—Elongate, curved, but slightly corrugated, with a fairly-developed head and a dorsal prothoracic shield, three pairs of jointed legs on the thorax; abdominal segments taper posteriorly, the last ending in two processes.

Life History.

Student Littlewood, of the Dehra Dun Forest School, took a number of these beetles sucking the sap oozing from newly blazed places on *Buchanania latifolia* trees in February 1902 in the Dun forests. In April 1909 I found the beetle feeding on the sap at the cut surfaces of logs and stumps of newly felled sál-trees in Mandla, in the Central Provinces.

This beetle is also often found in drying or dead fruits and seeds of trees, and in the tunnels of *Sinoxylon* and other bamboo-borers, whilst the grub is a common occupant of the inner surface of the spathes of the *Dendrocalamus* bamboo in North India.

Carpophilus mutilatus, Erichs.

Reference.—Erichs. *Deutsche Zeitschr.* iv, p. 258.

Habitat.—Siwaliks, North India.

Tree Infested.—*Buchanania latifolia.* Dun Forests.

Beetle.—Elongate. Brown, shining. Head narrower than prothorax, punctate. Prothorax wider than long, finely and irregularly punctate, with depressions near basal edge. Scutellum large. Elytra short, truncate, leaving several abdominal segments exposed; punctate, sparsely clothed with short golden hair; pygidium punctate, the basal part of last but one and last segment clothed with a short pubescence. Length, 3.5 mm. to 3.9 mm.

This insect was taken by Mr. Littlewood in company with *C. hemipterus* feeding at sap on *Buchanania latifolia.*

Carpophilus foveicollis, Murray.

REFERENCE.—Murr. *Mon. Trans. Linn. Soc.* xxiv, 3, p. 344 (1864).

Beetle.—Elongate, constricted behind. Shining black, elytra and pygidium brown, undersurface lighter coloured, legs yellow brown. Head small, punctate. Prothorax convex, shining, wider than long, anterior margin straight, sides curved; punctate. Elytra flat, highly punctate; three abdominal segments fully exposed, these highly punctate. Length, 5.5 mm. to 5.9 mm.

Lefroy, in *Indian Insect Life* (p. 297), mentions that he has taken this insect, in company with *C. hemipterus*, "under the sheathing leaves of bamboos, where their larvae live; and the latter (*C. foveicollis*), with other species, breeds freely in dried fruits in stores and godowns."

Carpophilus flavipes. Murray.

REFERENCE.—Murr. *Mon. Trans. Linn. Soc.* xxiv, p. 359 (1867).

Habitat.—Siwaliks, North India.

Tree Infested. — Sál (*Shorea robusta*). Dholkhand, Siwaliks.

Beetle.—Small, black, moderately shining, highly punctate. Prothorax not much wider than long, convex, anterior angles produced slightly forward, highly punctate. Scutellum large, punctate. Elytra short, truncate, convex; pygidium clothed apically with a fine pubescence. Legs yellowish brown. Length, 4 mm.

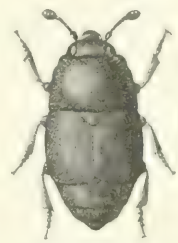


FIG. 72.—*Carpophilus flavipes*. Siwaliks.

Life History.

I first took specimens of this small *Carpophilus* from beneath the bark of felled sál-trees near Dholkhand in the Siwaliks towards the end of January 1901. I have since taken the beetle, often in similar positions, in the winter in the Siwaliks. The imago feeds on sap.

Carpophilus ? sp.

REFERENCE.—Determined doubtfully as a species of *Carpophilus*.

FIG. 73. *Carpophilus* ? sp. Siwaliks.

Habitat.—Siwaliks, North India.

Tree Infested.—Sál (*Shorea robusta*). Dholkhand.

Beetle.—Resembles *flavipes*. Anterior angles of prothorax not produced, anterior margin straight, sides curved; elytra with sides nearly straight, as wide apically as at base; pygidium more constricted behind.

I have taken this insect, in company with *C. flavipes*, in the sál in the Siwaliks forests in similar positions to those occupied by the latter species.

Carpophilus obsoletus, Erichs.

REFERENCE.—Erichs. *Deutsche Zeitschr.* iv, p. [illegible]

Habitat.—Siwaliks, North India. Also reported from Madras, Ceylon.

Tree Infested.—*Buchanania latifolia*. Dun Forests.

Beetle.—Larger than *flavipes*. Black, moderately shining, highly punctate. Head small, punctate. Prothorax large, convex, highly punctate, sides rounded in front, straight behind. Elytra short, truncate, leave exposed two full and a partial third abdominal segments. Legs blackish brown. Length, 3.8 to 4 mm.

Taken by Student Littlewood feeding at sap on blazed *Buchanania latifolia* trees in the Dun forests.

Tetrisus.

Tetrisus sp.

Reference.—Determined as a species of *Tetrisus* by Monsieur A. Grouvelle.

Habitat.—Goalpara, Assam.

Tree Infested.—Sál (*Shorea robusta*). Kachugaon, Goalpara.

Beetle.—Flat, light brown in colour. Upper surface very finely punctate. Prothorax wider than long, sides rounded. Scutellum large. Elytra short. Hind coxae large transverse. Length, 3 mm. to 3.2 mm.

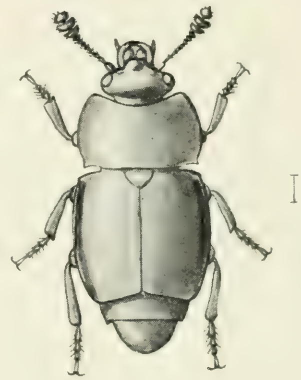


Fig. 74.—*Tetrisus* sp. Goalpara, Assam.

Life History.

I found a number of this nitidulid at Kachugaon on 16 May 1906 feeding on the sap oozing from the bark at one end of a felled green log cut a couple of days previously. During the next few days I found other specimens of the insect engaged in the same way. The beetles seem to possess the instinct which enables them to discover felled green trees with the sap oozing from the fresh-cut surfaces as quickly as do their cerambyx and scolytid companions.

Ecnomaeus.

Ecnomaeus haroldi, Reitt.

Reference.—Reitt. *Verh. Ver. Brünn.* xii, p. 182 (1874).

Habitat.—Siwaliks, North India.

Tree Infested.—Sál (*Shorea robusta*). Dholkhand, Siwaliks.

Beetle.—A tiny, flat, elongate, reddish-brown beetle, the elytra leaving exposed two segments of the body. Prothorax wider than head, anterior angles produced, sides rounded, base truncate. Elytra nearly as wide as thorax at base, wider behind, apex truncate, finely punctate; pygidium finely punctate, fringed with hairs. Legs lighter-coloured. Length, 6 mm to 8.5 mm.

I took specimens of this nitidulid from beneath the bark of a felled sál-tree at Dholkhand in the Siwalik Division towards the end of January.

Ecnomaeus waterhousei, Grouv.

Habitat.—Siwaliks, North India.

Tree Infested.—Sál (*Shorea robusta*). Dholkhand, Siwaliks.

Beetle.—Elongate, flat, much narrower than *haroldi*. Shining brown. Head elongate, concave on top. Eyes black, large, placed at base of head on either side. Prothorax slightly wider than long, margins channelled, punctate. Elytra elongate, slightly convex on disk, punctate; apex truncate, leaving exposed three abdominal segments which are punctate. Under-surface and legs lighter-coloured. Length, 7.7 mm.

Life History.

I took a specimen of this beetle from beneath the bark of a felled sál-tree at Dholkhand, in the Siwaliks, in January 1902. The insect proved new to science, and forms the type of the species in the British Museum collections. The species was taken in company with *E. haroldi*.

Family COLYDIIDAE.

The minute beetles of this family are fairly plentiful throughout the forests of the country, and for many reasons they may to the uninitiated be easily mistaken for serious bark-boring pests. Investigations seem to show, however, that this family does little, if any, damage in the forest, whilst some of its members are of high utility as predaceous foes of the tree pests.

Beetle.

The beetle is elongate or squarish in shape, and in the case of the bark forms flat. The antennae are clubbed at the top, and the tarsi four-jointed, with five ventral segments of the abdomen visible. The elytra have often plainly marked series of raised longitudinal striae down them, and the thorax is sometimes channelled or sculptured. The colours are browns, yellow-browns, and greys.

Perhaps the commonest predator beetles of the family met with in India are the species of *Bothrideres* which are predaceous upon the *Sinoxylon* and *Dinoderus* borers of wood and bamboo. These are the small, elongate, brown, flat beetles which are commonly found in the tunnels of the borers, and may be easily mistaken, and in fact have often been mistaken, for the authors of the damage themselves. Investigation has shown, however, that the insects are predaceous upon the beetle-borers, and lay their eggs in the galleries of the latter.

Larva.

I have at times taken various larvae which I have placed as colydiid ones, and in the hope that investigations may be carried out in this direction a description of one of these forms may be attempted here. The notes were recorded on the grubs at the time they were taken from the trees.

Larva taken from bark-beetle galleries in blue-pine trees in the North-West Himalaya: Head black, with three-jointed antennae, the upper joint longer than other two. Twelve segments follow the head, the first and last orange-yellow; rest black, each with a median dorsal orange spot; the segments are flat and broadish medianly. The posterior segment terminates in two black-pointed stout cerci jointed and curved inwards. Legs two-

jointed, yellow at base, last joint black. Ventral surface yellow, edged with black on segments two to eleven inclusive. The twelfth segment is provided with an abdominal sucker leg; the upper functional part divided into two surfaces.

I endeavoured to rear the beetle from this grub, but failed.

I have taken colydiid beetles in a number of forest trees throughout the country, amongst which may be mentioned most of the conifers and oaks of the Western Himalaya, and the sál, teak, pyinkadu, *Anogeissus*, *Lagerströmia*, *Erythrina*, *Dalbergia*, *Wendlandia*, *Morus*, *Buchanania*, etc.

Bothrideres.

Species of this genus are known to be predaceous upon bark- and wood-boring beetles in trees.

Bothrideres andrewesi, Grouv.

References.—Stebbing, *Depart. Notes*, p. 21 (1902).

Habitat.—Changa Manga, Punjab.

Habits.—This beetle is predaceous upon the wood-borers *Sinoxylon crassum* and *S. anale*. It is a fairly common insect in the galleries of the borers in sissu at the Changa Manga Plantation near Lahore (*vide* p. 165).

Bothrideres vallatus, Grouv.

Habitat.—Siwaliks, North India.

Habits.—Specimens of this beetle were taken from under the bark of a dead *Lagerströmia parviflora* tree and from tunnels in the cambium layer of a newly felled dead *Erythrina suberosa*. The beetles were taken by Student B. C. Sen Gupta in the middle of February 1902 at Bulawala in the Dun forests.

I also took specimens of this or a closely allied species of *Bothrideres* from beneath the bark of sál-trees at Dholkhand in the Siwaliks in January 1902.

Bothrideres ? sp.

Habitat.—Goalpara, Assam.

Habits.—I bred out a specimen of this beetle from a pupa taken from a partially complete pupal chamber of *Hoplocerambyx spinicornis* in sál, in Goalpara, in 1906. The shrivelled skin of the cerambycid grub lay in the chamber beside the colydiid beetle (*vide* p. 334).

TRACHYPHOLIS.

Two species of this genus have been taken in the Burma forests.

Trachypholis hispida, Weber.

REFERENCE.—Weber, *Obs. Ent.* i, p. 38.

Habitat.—Upper and Lower Burma, Tenasserim.

Trees Infested.—*Anogeissus latifolia* (Tharrawaddy); Teak (*Tectona grandis*). Mohnyin Forest, Katha; Wutgyi, Salween River, Tenasserim.

Beetle.—Ovate, flat, the edges of thorax and elytra set with a spiny fringe of hairs. Black. Prothorax wider than long, depressed laterally and margined; rugose-punctate. Elytra with sides straight to apical fourth, thence constricted and conjointly rounded; surface broadly striate and strongly punctate, the punctures large. Length, 6 mm.

Habits.—This beetle was first taken on 22 January 1905, beneath the bark of an *Anogeissus latifolia* tree in Tharrawaddy which was badly infested by several bark- and wood-boring beetles, the chief of which was *Platypus rectangulatus* (p. 623). The insect is undoubtedly predaceous, and probably chiefly on the *Platypus*, in whose tunnels it was taken as well as beneath the bark. The beetle is very active and a quick runner. The following month (19th) I took the insect beneath the bark of a large standing girdled teak in the Kadu depot in Katha in Upper Burma. Here I noted that the pupal chambers of the beetles appeared to be in the inner bark of the tree. On 7 March following I again took the beetle from beneath the bark of a dead felled teak in a paddy clearing at Wutgyi on the Salween River in Tenasserim. The *Trachypholis* is apparently predaceous upon more than one species of insect.

FIG. 75.—*Trachypholis hispida*, Weber. Burma.

Trachypholis decorata, Grouvelle.

Habitat.—Katha, Upper Burma.

Tree Infested.—*Wendlandia tinctoria*. Mohnyin Forest.

Beetle.—Larger and broader than last. Black with small tufts of yellowish pubescence forming spots on thorax and elytra. Sides of thorax are more rounded; the apical fourth of elytra more sharply constricted, the apex truncate; elytra slightly convex on disk; punctate, the punctures arranged in longitudinal rows. Length, 8 mm.

Description.

Habits.—I took a specimen of this beetle from beneath the bark of a large felled *Wendlandia tinctoria* tree in a clearing on Kadu Hill in the Mohnyin forests in Katha. The beetle was fully mature, and appeared to be hibernating in the tree. The tree was infested by platypids (p. 627).

FIG. 76.—*Trachypholis decorata*, Grouvelle. Burma.

Family TROGOSITIDAE.

Some of the forest forms of this family are readily recognizable owing to their elongate black form, with the large square prothorax and prominent head and mandibles. Others are not, however, so easy to distinguish.

Beetle.

The antennae have often the terminal joints expanded to one side, thus rather resembling the lamellicorn antennae ; the eyes and mandibles usually well developed ; the elytra, which wholly cover the body, are often prominently striate-punctate, and the legs short with four-jointed tarsi (there are five joints, the first being very small).

Larva.

The grub of this family is elongate, white or yellow (so far as is known), with a black or brown head and prothorax, with well-developed mandibles, and a pair of calliper-like processes terminating the last segment of the body.

The forest species of the family known are predaceous in both the larval and beetle stages, and the importance of some of the species in keeping down the numbers of wood- and bark-boring pests is very considerable. The family will well repay a close study on the part of the forester.

ALINDRIA.

Alindria orientalis, var. **parallela**, Leveillé.

REFERENCE.—Lev. *Ann. Soc. Ent. Fr.* (6) viii, p. 411 (1888).

Habitat.—Changa Manga Plantation, Punjab.

Habits.—Predaceous upon the wood-borers *Sinoxylon crassum* and *S. anale* (*vide* p. 165).

FIG. 77.—*Alindria orientalis*, Redt. Changa Manga.

Alindria orientalis, Redtenb.

REFERENCE.—Redtenb, *Hügel, Kasch.* iv, 2, p. 549.

Habitat.—Changa Manga Plantation, Punjab.

Habits.—Predaceous upon the wood-borers *Sinoxylon crassum* and *S. anale* (*vide* p. 165).

FIG. 78.—*Melambia crenicollis*, Gnév. Siwaliks, Mandla.

MELAMBIA.

Melambia crenicollis, Gnév.

REFERENCE.—Gnév. *Ic. Règneanim.* p. 199, t. 41. f. 12 (1846).

Habitat.—Dholkhand, Siwaliks, North India; Mandla, Central Provinces.

Habits. — Feeds predaceously on *Sinoxylon crassum* in sál and *Terminalia chebula* (*vide* p. 166).

Melambia sp. prox. memnonia, Pascoe.

REFERENCE.—Pascoe, *Journ. of Ent.* i, p. 320, 1862.

Habitat.—Changa Manga Plantation, Punjab.

Habits.—Predaceous upon the wood-borers *Sinoxylon crassum* and *S. anale* (*vide* p. 166).

TENEBROIDES.

Tenebroides (Trogositita) rhizophragoides, Walker.

REFERENCE.—Walker, *Ann. Nat. Hist.* 3rd ser. iii, p. 53 (1859).

Habitat.—Seoni, Central Provinces.

Habits.—Feeds predaceously on *Sinoxylon crassum* in *Terminalia tomentosa* in the Central Provinces (*vide* p. 166).

TIMNOCHILA.

Timnochila coerulea, Olivier, var.

REFERENCE.—Oliv. *Ent.* ii, 19, p. 6, pl. i, fig. 1.

Habitat.—North-West Himalaya.

Habits.—This elongate blue-black large trogositid is predaceous upon the bark-borers *Tomicus longifolia* and *Polygraphus longifolia* in the chir pine (*Pinus longifolia*). I first took specimens of it at Jermola in Jaunsar in the Western Himalaya. It may also attack the cryptorhynchid weevil of this pine, but that I have not personally observed. The insect is a most useful one in the forest (*vide* p. 561).

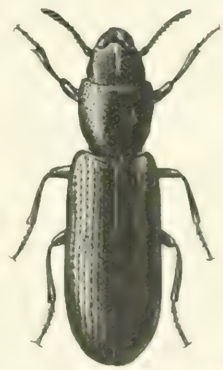


FIG. 79.—*Timnochila coerulea*, var. N.W. Himalaya.

Family CUCUJIDAE.

Beetle.

The forest members of this family vary considerably in appearance. Some have the small flattened, rounded, or squarish forms and brown or yellow colour which is commonest in the family. Others, however, differ entirely from this type, having elongate black shining forms with heavily jointed and knobbed antennae (e.g. *Hectarthrum*). The tarsus in the family is apparently four-jointed, and the antennae are long, often with a clubbed top to them.

The larva is an elongate grub with jointed antennae on a large head, three pairs of jointed legs on the thoracic segments, which are not much wider than the abdominal segments, the last three or four of which may taper posteriorly, the last being small, or the abdominal segments may increase in size and width posteriorly, the last being large and terminating in small processes.

Some of the members are, as mentioned already, easy to distinguish; but the majority perhaps are by no means easy to recognize.

This family of beetles contains representatives having totally dissimilar habits in the forest. Some, such as *Silvanus*, feed on dry or decaying materials; in one case a species of this genus appears to produce curious excrescences or galls on the leaves of the teak-tree. Species of *Loemophloeus* are commonly found in decaying bark and other parts of the tree. *Laemotmetus*, on the other hand, are found feeding at the sap of cut stumps and wounds on trees, the beetles being often confused with bark beetles, although in reality of course they do no or little harm in the forest so far as is yet known. Yet another genus, *Hectarthrum*, has quite dissimilar habits, as the members at present known in the forest are all predaceous, feeding upon various kinds of bark- and wood-eating beetles.

Hectarthrum.

A genus of elongate, narrow, shining black beetles with prominent antennae, mandibles, and more or less deeply channelled and punctate elytra. The insects are predaceous.

Hectarthrum heros, Fabr.

Reference.—Fabr. *Syst. Eleuth.* ii, p. 92.

Habitat.—Central Provinces, Burma.

Habits.—The beetle has apparently a fairly wide distribution in India. I have taken it in Seoni and Mandla in the Central Provinces and also very plentifully in Tharrawaddy and Tenasserim in Lower Burma. Lefroy (*Indian Insect Life*) mentions it as common under the bark of trees without giving any localities.

I have found this *Hectarthrum* predaceous upon *Sinoxylon crassum* in *Terminalia tomentosa* and *T. chebula* in the Central Provinces (p. 166).

In Burma it would appear to feed upon a variety of wood- and bark-boring insects, including termites. I took it in *Adina sessilifolia* feeding upon the *Platypus suffodiens* which riddles the wood of this tree (p. 621), and in *Anogeissus latifolia* feeding on termites and other bark and wood insects, both in Tharrawaddy. I also took it in pyinkadu on the Salween River feeding on the pyinkadu platypid (see p. 634).

Fig. 80.—*Hectarthrum trigeminum*, Newm. Siwaliks.

Hectarthrum trigeminum, Newm.

Reference.—Newm. *Ann. Nat. Hist.* p. 393 (1839).

Habitat.—Siwaliks, Dehra Dun.

Habits.—Student B. C. S. Gupta (now of the Bengal Provincial Service) took specimens of this insect under the bark of a dead *Lagerströmia parviflora* tree at Bulawala in the Siwaliks on 17 February 1902. The insect is probably predaceous.

Hectarthrum uniforme, Waterh.

Habitat.—Salween River, Tenasserim.

Habits.—I took some specimens of this beetle from beneath the bark of a large dead standing *Miluisa velutina* tree on Kowloon Island in the Salween River on 9 March 1905. The tree was infested and the sapwood riddled by a species of termite, a few wood-boring larvae being present. The *Hectarthrum* was feeding upon the termites. The insect is shown in fig. 13.

Laemotmetus.

Laemotmetus insignis, Grouvelle.

Reference.—Grouvelle, *Ind. Mus. Notes*, iii, 1, p. 22.

Habitat.—Thana District, Bombay.

Tree Infested.—*Terminalia belerica :* Thana District (F. Gleadow); *Terminalia tomentosa :* Seoni, Central Provinces.

Beetle.—Elongate, shining, red-brown. Head depressed, a median cleft in front, finely punctate. Eyes placed at sides on under-surface near base. Prothorax convex, constricted, and rounded behind, anterior edge straight ; punctate. Elytra elongate, parallel, conjointly rounded, strongly striate, and finely punctate. Under-surface shining, punctate ; legs lighter-coloured. Length, 8.5 mm. to 9 mm.

Life History.

Specimens of this small beetle were sent to the Indian Museum, Calcutta, in February 1891 by Mr. F. Gleadow, I.F.S. Mr. Gleadow reported that he found them infesting the *Terminalia belerica* in the Thana district in company with a wood-boring *Sinoxylon* beetle.

In September 1901 I obtained specimens of the insect from galleries of *Sinoxylon crassum* in a *Terminalia tomentosa* pole sent me from Seoni, in the Central Provinces.

Inopeplus.

Inopeplus sp.

Habitat.—Katha, Upper Burma.

Tree Infested.—*Schima noronhae.* Kadu Hill, Katha.

Beetle.—Elongate, narrow, flat. Bright copper-coloured, with abnormally long antennae. Head and prothorax small, narrow, punctate. Elytra much broader, sides parallel, apex rounded, striate-punctate. Length, 8.10 mm.

Life History.

I found this beetle in numbers beneath the bark of a felled *Schima noronhae* tree, in the teak forest on the Kadu Hill, Katha, towards the end of February 1905. The bast and sapwood of the tree were fresh, and the beetles may be sap feeders.

PLATYCOTYLUS.

Platycotylus inusitatus, Olliff.

Habitat.—Siwaliks, North India; Seoni, Central Provinces. Also reported from Andaman Islands and North Borneo.

Trees Infested.—*Lagerströmia parviflora* and *Erythrina suberosa:* Bulawala, the Dun Forests (B. Sen Gupta); *Terminalia tomentosa:* Seoni.

Beetle.—Elongate. Shining. Head and prothorax dark brown; elytra red or crimson brown, darker along the suture; antennae brown; legs brownish yellow. Head small, punctate. Prothorax wider than head, anterior angles produced, sides rounded, base truncate, shining, punctate. Scutellum elongate. Elytra strongly striate-punctate, slightly constricted behind, apex rounded, pygidium yellow. Under-surface light reddish brown. Length, 6.5 mm.

Life History.

Specimens of this insect were taken about the middle of February 1902 by Student B. Sen Gupta from beneath the bark of a dead *Lagerströmia parviflora* tree. Mr. Gupta subsequently found others in the rotting cambium of the inner bark of a dead recently felled *Erythrina suberosa*. The insect was in the imago stage.

In September 1901 I obtained specimens of this insect from the galleries of *Sinoxylon crassum* in the wood of a *Terminalia tomentosa* obtained from Seoni in the Central Provinces.

LAEMOPHLOEUS.

Laemophloeus testaceus, Fabr.

REFERENCE.—Fabr. *Mant. I.* p. 166.

Habitat.—Siwaliks, North India.

Tree Infested.—Sál (*Shorea robusta*). Dholkhand, Siwaliks.

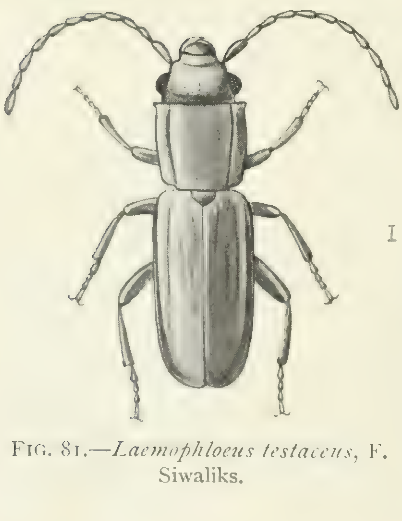


FIG. 81.—*Laemophloeus testaceus*, F. Siwaliks.

Beetle.—Very small, with elongate brown antennae. Light brown, shining, the elytra yellowish brown; legs yellowish.

Description.

Head finely punctate. Prothorax smooth, square, with a longitudinal lateral depression near each edge. Scutellum large. Elytra elongate, sides straight, apex rounded; surface smooth. Hind femora rather broad, smooth, shining. Length, 2.1 mm.

I took specimens of this small cucujid from beneath the bark of a felled sál-tree at Dholkhand in the Siwaliks in January. The insect appears to feed on the dead cambium of the tree.

Psammoecus.

Psammoecus trimaculatus, Motsch.

Habitat.—South Coimbatore, Madras.

Tree Infested.—Bamboo (*Dendrocalamus strictus*). Mount Stuart, South Coimbatore.

Description.

Beetle.—Small, elongate, yellow to yellowish brown, covered with spiny hairs; under-surface darker-coloured. Head small, punctate. Prothorax convex, the edges with several sharp teeth, largest medianly; disk punctate. Scutellum small. Elytra broader than thorax, base straight, humeral angles rounded, widest at posterior coxae, constricted apically and rounded; longitudinally and finely striate and punctate. Antennae and legs set with spiny setae. Length, 2.4 mm. to 2.8 mm.

FIG. 82.—*Psammoecus trimaculatus*, Motsch. Coimbatore, Madras.

I cut out some specimens of this small beetle from galleries in the wood structure of bamboos (*D. strictus*) in the forests round Mount Stuart in South Coimbatore. The beetles were taken at the end of July 1902.

Silvanus.

Silvanus surinamensis, Linn.

REFERENCES.—Linn. *Syst. Nat.* i, 2, p. 565; Lefroy, *Ind. Ins. Life*, p. 300 (1909).

Habitat.—Northern India.

Tree Infested.—Mohwa (*Bassia latifolia*). Western India (Lefroy).

Description.

Beetle.—Elongate, smoky brown, dull. Head large, punctate; eyes placed at sides a little above base; antennae long and clubbed. Prothorax longer than wide, with three prominent longitudinal ridges, one median and two lateral, bounding two elongate depressed channels, the sides toothed. Elytra elongate, parallel, slightly constricting at apex, striate-punctate, the striae most prominent at base. Under-surface brown, legs lighter-coloured, abdominal segments clothed with a fine golden pubescence. Length, 4.3 mm.

Larva.—Elongate, whitish yellow, with prominent head and prothoracic segments. Antennae and three pairs of legs jointed. Abdominal segments but slightly smaller than thoracic, save last four, which taper, the last being small. Length, 6.5 mm.

Life History.

This insect passes through several generations in the year. Lefroy in *Indian Insect Life* has the following note on its habits:—

"The larva lives in dried fruit, flour, dried mohwa (the calyx of *Bassia latifolia*), and similar vegetable matter. The complete life history occupies about seven weeks; the eggs are laid in the food, the larvae feed inside or between two pieces, and pupate in a chamber closed in

with bitten pieces of their food. This insect causes considerable annual loss in India, attacking mohwa, for instance, during the rainy weather and breeding in it steadily till much is lost."

Silvanus lateritius, Reitter.

Habitat.—Siwaliks, North India.

Trees Infested.—*Lagerströmia parviflora* and *Erythrina suberosa*. Bulawala, Siwaliks (B. Sen Gupta).

Description.

Beetle.—Flat, elongate, narrow, brown. Head triangular, punctate; eyes large, black, placed at sides near base of head. Prothorax longer than wide, narrower behind, flat; a raised longitudinal median ridge on disk, with a depression on each side, highly punctate. Elytra elongate, constricted to apex, where they do not quite cover abdomen; strongly punctate-striate. Legs with thickened femora, and tibiae thickened at upper end. Under-surface darker in colour. Length, 5.5 mm.

Life History.

Specimens of this beetle were taken from beneath the bark of dead *Lagerströmia parviflora* and *Erythrina suberosa* trees at Bulawala in February 1902 by Student B. Sen Gupta of the Imperial Forest School.

The beetles were either hibernating or feeding on the dead cambium layer.

Silvanus advena, Walth.

(Teak Leaf Gall Maker.)

REFERENCE.—Walth. *Faunus*, i, p. 169 (1832).

FIG. 83.—*Silvanus advena*, Walth. Central Provinces.

Habitat.—Central Provinces, Berar, Madras, Bombay.

Tree Attacked.—Teak (*Tectona grandis*). Damoh, Central Provinces; Melghat, Berar; Poona; Coimbatore.

Description.

Beetle.—Elongate, very small, with clubbed antennae. Light brown, the elytra yellowish brown. Head flat, punctate; eyes black, placed at sides. Prothorax wider than long rather square, moderately convex medianly, punctate. Elytra with sides straight to apical third, thence constricted and conjointly rounded; surface smooth, very finely punctate. Under-surface darker red-brown, punctate. Length, 2 mm.

Larva.—Dark orange in colour.

Life History.

The leaves of the teak throughout India (Central Provinces, Bombay, and Madras) are attacked by a small *Silvanus* grub whose operations cause the tissues of the under-surface of the leaf to swell up into a small gall. This gall consists of a small round yellowish lump on the under-surface of the leaf

covered with a furry coating, this pubescence being at times quite long. The leaves are often entirely covered on their lower surfaces with these galls. Later on the upper surface of the leaf turns black and decays and the leaf drops. The damage done therefore amounts to partial or complete defoliation.

The life history of the insect causing these galls is still incompletely known.

From galls containing partially grown larvae taken in the Damoh forests of the Central Provinces in the middle of August I bred out this insect in Dehra Dun on the 18th of the following September. The mature beetles therefore issue from the galls towards the end of the monsoon season and before the leaf drops from the tree.

On several occasions Mr. G. Ryan has sent me specimens of teak leaves attacked by this insect from Thana and elsewhere in the Bombay Presidency.

FIG. 84.—*Languria zyanea*, Hope. N.W. Himalaya.

Family EROTYLIDAE.

Elongate beetles, often brightly coloured, the antennae with a club of three or four joints and an apparently four-jointed tarsus. The elytra of some forms found in the forest are brilliantly coloured, and often metallic. The insect figured here, *Languria zyanea*, as an example of the family, is not uncommon in the Western Himalaya in July. The larvae feed in the stems of plants, tunnelling up the centre. No forest species have been observed to act in this manner, but little is known about the family in the forest.

Family COCCINELLIDAE.

(*Ladybird Beetles.*)

The ladybird beetles are for the most part easy of recognition, owing to their rounded or oval shape and to the apparently three-jointed tarsus of the feet ; the antennae are short and not clubbed. The beetles are often brightly coloured, or have patches, stripes, or spots of brilliant colour on a duller-coloured ground. The colouring is the common red or brown, yellow or black.

Beetle.

The beetle is usually of small size, having perhaps some resemblance to the chrysomelid beetle, but can be distinguished from the latter by the three-jointed tarsus (instead of four). The prothorax is small, almost covering the head, and with the elytra forms a perfect curve on the outside. The dorsal surface is usually convex, the ventral flat. The antennae are not very long, the legs short. Length, up to a little over one-fourth of an inch.

Larva. The grub is an elongated, campodeiform, active grub, grey or black, at times yellow or red, in colour. The body is usually widest across the middle and tapering to either end, the head being small and inconspicuous, whilst the thoracic segments are large and, with the abdominal segments, bear spines and tubercles. The last segment is provided with a swelling or pseudo-sucker which is used by the grub in moving about.

Pupa. The grub pupates in the open on the plant, fixing itself to a leaf or twig by means of the anal foot. The larval skin splits down, disclosing the oval-shaped pupa and often remains partly surrounding it.

Most of the Coccinellidae are predaceous insects, though a small section of the family are vegetable feeders. The predaceous forms feed chiefly on plant lice, Aphidae and Coccidae, and all the species known to be of importance to the forest are of this nature.

Life History. The life history is simple. The grubs and beetles prey upon the host, the grubs being the most voracious, spending several weeks on the trees and plants in pursuit of their prey, which they puncture and then suck out the juices of the insects, leaving an empty skin behind. The pupal stage is short. The beetle on maturing also feeds for a time at least in the case of some species, the [illegible] of the sal Monophlebus, for instance, this is so. The species then mate and either lay eggs on the tree on which they fed or, as I have myself observed, or, according to Lefroy (Indian Insect Life, p. [illegible]), "remaining for long periods without food, awaiting the proper conditions of egg laying."

The eggs are laid in clusters on the leaves or twigs of the trees, in shape being elongate and resembling a [illegible] bottle.

There is little doubt that the insects are of high economic importance in the forest. To quote but one instance, the [illegible], which preys upon the Monophlebus scale insect of the Central Provinces of Bengal, undoubtedly plays an important part in keeping this pest in check, and is generally effecting a beneficial [illegible] work.

Hippodamia.

Hippodamia variegata var. *doubledayi*, Muls.

[illegible]

Habitat.—Dehra Dun, North India.

Habits.—I have taken this insect feeding upon the immature aphids of the [illegible] in the Dun Plantations in North India. The insect may be taken in abundance in the hot weather.

Hippodamia constellata, Gorh.

References.—[illegible]

Fig. 15.—Hippodamia constellata, Gorh. N.W. Himalaya.

Habitat.—North-West Himalaya. Gorham gives the distribution as India, Central Asia.

Habits.—I have taken this species commonly in the North-West Himalaya in May–June at elevations of 7,000 ft. to 9,000 ft. It is predaceous upon the spruce and silver-fir *Chermes himalayensis*, Stebbing, and upon the blue-pine aphis.

COCCINELLA.

The common European seven-spotted ladybird beetle is widely distributed over Northern India, and occurs sparingly further south. It is found up to 11,000 ft. in the Western Himalaya.

Coccinella septempunctata, Linn.

References.—Linn. Syst. Nat. [illegible]

Habitat.—Himalaya, North India.

Habits.—Predaceous in larval and beetle stages on *Chermes himalayensis*, Stebbing, on the spruce and silver-fir, and on the blue-pine aphis, *Lachnus* sp., on the blue pine, both in the Western Himalaya.

COELOPHORA.

Coelophora saucia, Muls.

References.—Muls. [illegible]

Habitat.—Dehra Dun Plateau, North India.

Habits.—I have taken both larvae and beetles of this ladybird feeding upon the common peach aphis on peach-trees in the Dehra Dun Plateau in May.

CHILOMENES.

Chilomenes sexmaculata, Fabr.

References.—Fabr. [illegible]

Habitat.—Dehra Dun Plateau, North India. Also reported from Calcutta (Sibpur), Behar (Pusa), Ranchi. Said to be common throughout India.

Habits.—Predaceous upon the peach aphis in the Dehra Dun Plateau.

CHILOCORUS.

Chilocorus circumdatus, Schön.

REFERENCES.—Schön. (*Coccinella*) *Syn. Ins.* ii, 152 (1808); Muls. *Spec.* p. 454, 2; *nigromarginatus*, Mots. *Et. Ent.* viii, 170; *Ind. Mus. Notes*, ii, 6, 154; vi, 4, 218.

Habitat.—Nilgiris, Madras; Ceylon.

Habits.—This coccinellid is predaceous upon the brown bug *Lecanium caffeae*, of coffee, and is said to be of considerable value in this way.

FIG. 86.—*Brumus suturalis*, Fabr. Dehra Dun.

BRUMUS.

Brumus suturalis, Fabr.

REFERENCES.—Fabr. (*Coccinella*) *Suppl. Ent. Syst.* p. 78 (1798); Muls. *Spec.* p. 494, 2.

Habitat.—Dehra Dun Plateau, North India. Also reported from Madras.

Habits.—Predaceous upon the peach aphis in the Dun Plateau.

PLATYNASPIS.

Platynaspis luteo-rubra, Goeze.

REFERENCES.—Goeze (*Coccinella*) *Ent. Beyt.* i, p. 247 (1874); *villosa*, Muls. *Sécur.* p. 216, 1 (1846); Fourc. *Ent. Par.* 1, 149, 22 (1785); *Ind. Mus. Notes*, iii, 5, 50; v, 3, 63, pl. ix, fig. 3 (imago).

Habitat.—Calcutta.

Habits.—This insect is predaceous upon the scale insect *Icerya aegyptiaca*, which feeds upon the teak.

SCYMNUS.

Scymnus rotundatus, Mots.

REFERENCES.—Mots. *Et. Ent.* viii, p. 170 (1859); *Ind. Mus. Notes*, i, 6, 154; iv, 4, 218.

Habitat.—Ceylon.

Habits.—This insect is reported in Ceylon to be predaceous upon the white bug of coffee bushes, *Pseudococcus adonidum*.

Scymnus sp.

REFERENCE.—*Ind. Mus. Notes*, iii, 5, 50.

Habitat.—Calcutta.

Habits.—Reported as having been found preying upon the scale *Icerya aegyptiaca* in the compound of the Indian Museum in Calcutta.

VEDALIA.

This genus includes an important species which preys upon the pernicious sál scale insect *Monophlebus*.

Vedalia guérinii, Crotch.

REFERENCES.—Crotch, *Rev. Coccinell.* p. 282 (1874); *Coccinella* sp. Stebbing, *Depart. Notes*, p. 324.

Habitat.—Siwaliks and United Provinces Terai areas. Also reported from Pondicherry (Guérin).

Habits.—This *Vedalia* preys upon the sál scale insect *Monophlebus stebbingi*, which infests the sál-trees in the Siwaliks and United Provinces Terai forests. The *Vedalia* swarms in large numbers when the scale insect is abundant in the trees. The egg, larval, pupal, and beetle stages of the coccinellid are known.

Vedalia fumida, var. roseipennis.

REFERENCES.—*Rodolia fumida*, Muls. *Spec.* p. 904, 4; *Epilachna arethusa*, Muls. *Op.* iii, p. 120; *testicolor*, Muls. *Op.* iii, p. 127; *Rodolia roseipennis*, Muls. *Spec.* p. 904, 5; *Rodolia chermesiana*, Muls. *Spec.* p. 905, 6; Crotch, *Rev. Coccinell.* 1874; *Ind. Mus. Notes*, iv, 1, 27; 4, 218.

Habitat.—Siwaliks, North India. Also reported from Bengal (Deyrolle).

Habits.—This beetle is found in company with *Vedalia guérinii*, preying upon the *Monophlebus stebbingi* scale insect in the Siwaliks sál forests. It is not, however, so abundant as its companion. It has also been reported as feeding upon the scale *Icerya aegyptiaca*.

Vedalia sp.

REFERENCE.—Stebbing, *Ind. Mus. Notes*, vi, p. 62.

Habitat.—Lahore, Punjab; Bareilly.

Habits.—This coccinellid has been taken preying upon the scale insect *Monophlebus stebbingi*, var. *mangiferae*, which infests the mango-trees in the Shaliman Gardens at Lahore, in the Punjab, and in the Bareilly Gardens.

It may possibly be identical with *Aulis bestita*, Muls., found feeding upon *Monophlebus* on mango-trees, and reported by Lefroy in *Mem. Agric. Dept. India*, vol. ii, no. vii.

Family ENDOMYCHIDAE.

A family of curiously shaped beetles with rather long antennae, which end in a comparatively large three-jointed club. The tarsi appear to be three-jointed, the last two joints being broad.

The beetles are sometimes brightly coloured, or have bright-coloured spots and markings on them. The insects are said to feed on fungus growths and lichens.

Little is known about the habits of the family in the forest. On one occasion I took a mature beetle beneath the bark of a tree, and I found another in the Charduar Rubber Plantation in Assam.

EUGONIUS.

Eugonius gratus, Gorh.

REFERENCE.—Gorh. *Ann. Soc. Ent. France*, lx, 399 (1891).

Habitat.—Katha, Upper Burma.

Tree Infested.—Teak (*Tectona grandis*). Mohnyin Forest, Katha.

FIG. 87.—*Eugonius gratus*, Gorh. Upper Burma.

Description. **Beetle.**—Elongate, ovate. Black, shining, with four transverse irregular-edged orange or yellow patches on the elytra. Head small, punctate; antennae long, clubbed. Prothorax with anterior edge deeply incised for insertion of head, the lateral margins channelled; disk convex, with a longitudinal median line and fine scattered punctures. Elytra convex, widest about middle, constricted apically, leaving a small pygidium exposed; finely punctate, the orange markings one on each side near base, the other in apical third. Femora thickened anteriorly. Length, 9.2 mm.

Life History. I took a mature specimen of this endomychid from beneath the bark of a standing girdled teak-tree in the Mohnyin Forest in Katha on 20 February 1905. Beyond the fact of taking the beetle in this curious position, I have no record of its habits.

Family DERMESTIDAE.

A family of small beetles with retractile heads, short clubbed antennae, and five-jointed tarsi, the upper and lower surfaces of the beetle being often clothed with pubescence.

The larva is elongate and cylindrical, tapering posteriorly, where it ends in two hooks; the body is clothed with stiff hairs, giving the grub the appearance of a small caterpillar.

Some members of the family are found under the bark of trees, but little is at present known about them. It is probable that some of them are predaceous upon bark- and wood-eating beetles, and so of use to the forester.

The two commonest beetles the forester will meet with are:

(1) **Dermestes vulpinus**, F.—The grubs of this beetle feed upon the pupa of the silkworm moth, gnawing through the silk cocoon to get at it. In this way they do serious damage to silk in India.

(2) **Anthrenus vorax**, Wat.—A common silvery-greyish, oval, thick beetle, with darker patches on the upper surface and silvery-white beneath, which is such a pest to the sportsman. This is the insect which destroys his skins and horns unless they are properly cured.

CHAPTER IX.

POLYMORPHA (*continued*)—Family BOSTRYCHIDAE.

THE Bostrychidae are a family of small elongate cylindrical beetles of circular section who in their ovipositing operations make pin-holes and "shot" holes in wood and bamboos. Owing to this habit of the beetles their work is probably better known to the public throughout India than is that of most of the other Indian forest insects. Whether the beetles themselves actually derive sustenance from the wood has not yet been proved. Their habit of tunnelling into it is at any rate primarily to oviposit in the interior, the larvae being entirely wood-eaters. Most of the Indian bamboos and the wood of a variety of trees are made use of for this purpose.

Some of the beetles are well known owing to their making their appearance in numbers in the bungalow at the periods at which they mature and swarm, either from neighbouring forest trees, or from the roofs, walls, and floors of the bungalow itself. They also issue from the furniture, especially bamboo-made articles. Many of the species appear to fly equally readily by day or night.

In spite of their small size, the largest being about one-third of an inch in length, they are easily recognizable, owing to their cylindrical form and dark brown or black colour, and to the hooded prothorax, which is often serrated and rasp-like on the anterior surface.

Beetle.

The beetles greatly resemble and are often mistaken for Scolytidae, the bark beetles. From these they may be distinguished by the afore-mentioned tuberculate and rasp-like prothorax, by the straight instead of elbowed antenna, which has a three-jointed club at its end, and by the five-jointed tarsi, the first or basal joint of which is small, the second and fifth being long. The outer integument or covering of the beetle is very hard, all the parts fitting well together, as is usually the case with wood-boring insects. The prothorax is occasionally furnished with hooks or frontal teeth in addition to the enlarged tuberculations, whilst the body is provided with one or more tubercles, probably used by the beetle in moving in its tunnel in the wood. The legs have broad femora and tibiae, the latter sometimes toothed on one edge.

FIG. 88.—*Heterobostrychus aequalis* Waterhouse. × 5. India and Burma.

The males and females in some species differ from each other, and also have curious modified characters which distinguish one male or female from another of the same species, due to modifications in the hooks and teeth of the prothorax and tubercles of the body.

Larva. The larva is white, curved, corrugated, soft and fleshy, furnished with powerful mandibles and a pair of four-jointed antennae, and three pairs of legs on the thoracic sections.

Pupa. The pupa (fig. 31, *a*) is soft, white, with a well-developed hood-like prothorax, the antennae, legs, and wings being pressed against the chest.

The *modus operandi* of the beetle is to tunnel through the bark down into the sapwood (or in the case of the bamboo into the wall), eating out a gallery of irregular length in which the eggs are laid at intervals. The larvae on hatching eat out irregular galleries running more or less in the long axis of the wood, pupating at the end of the tunnel when they have reached full growth. On maturing the beetle bores through the wood until it reaches an empty egg-tunnel, up which it crawls and escapes to the outside.

From a utilitarian point of view the family is one of the most destructive in the country, owing to the large amount of harm it does to felled timber and bamboos. This damage is well known, and timber contractors soak their cut bamboos and poles in water and then smoke the former to prevent the beetles from infesting them and reducing them to powder before their sale. This is done throughout the tropics. Also timber contractors will not cut bamboos and poles when the moon is full, as they hold the opinion that bamboos felled at this period are more subject to attack. Elsewhere this subject is discussed in detail (p. 140). That the damage done by the insects throughout the country to constructive material must run into very large figures is borne out by the fact that buildings which include bamboo and pole materials require continual attention and repairs in parts of the country. During the year 1903, whilst officiating as Superintendent of the Indian Museum, I carried out a series of experiments in conjunction with the Head of the Telegraph Workshops at Alipur, which proved that soaking the bamboos in crude rangoon oil rendered them immune to the attacks of *Dinoderus*, and bamboos so treated which were used for a light field telegraph on the Tibet Mission, 1904–5, stood the test well and remained unattacked for years afterwards (p. 137).

It has long been supposed that the bostrychids were wood-borers pure and simple, and did no damage to standing trees. Observations have shown, however, that species of *Sinoxylon* will attack and oviposit in sickly standing green trees. A worse habit in the case of one species, *Sinoxylon crassum*, has received some investigation. In February 1902, Mr. A. M. Littlewood, a student of the Imperial Forest School at Dehra, found an insect tunnelling

into the leading and side shoots of sál saplings and coppice shoots. This beetle proved to be *S. crassum*, which hibernates in the hollowed-out shoots. The beetles so taken were fully mature and alive, and were evidently hibernating. This observation I have been able to confirm by subsequent investigations (p. 156).

In April 1901 I made the first of a series of investigations I have carried out on the subject of the insect predators of the bostrychids—the first, so far as I am aware, that had been made. I discovered a species of *Bothrideres* and several *Teretriosomas* preying upon *Sinoxylon crassum* and *S. anale*. This discovery I subsequently communicated to Mr. G. Lewis and Monsieur P. Lesne. Further investigations have shown that a variety of insects follow the bostrychids into their tunnels in the wood, and either prey upon them there or lay their eggs in order that their larvae when hatched may feed upon the bostrychid larvae. This observation, which has been now authenticated by a number of observations and experiments, has an analogy in the case of the Scolytidae and Platypodidae, in which a similar state of affairs exists.

In the case of the bostrychids, predaceous species of *Tillus*, *Teretriosoma*, *Teretrius*, *Alindria*, *Melambia*, *Tenebroides*, and *Hectarthrum* are known to have habits of this kind.

Classification. The family is divided by Lesne into four divisions—I. Psoinae. II. Polyocaninae. III. Dinoderinae. IV. Bostrychinae.

Of these only the Dinoderinae and Bostrychinae contain, so far as is known at present, species of forest importance in India. The following characters serve to distinguish these two divisions.

Dinoderinae.—Tarsi shorter than the tibiae; last tarsal joint as long as or longer than the rest of the joints together. Prothorax convex, anterior margin rounded, with the median teeth the most prominent.

Bostrychinae.—Tarsi as long as or longer than tibiae; last joint shorter than the rest of the joints together; prothorax strongly tuberculate, the anterior margin with the lateral teeth more prominent than the median ones.

I. DINODERINAE.

This division includes the important genus *Dinoderus*, containing several species, two of which, *D. pilifrons* and *D. minutus*, are of high economic importance.

Dinóderus.

Second joint of antennae shorter than first. Posterior portion of prothorax punctate.

Dinoderus distinctus, Lesne.

References.—Lesne, *Ann. Soc. Ent. Fr.* lxvi, 325 (1897); Stebbing, *Ind. Mus. Notes*, vi, 20 (1903).

Habitat.—Dehra Dun Plateau, North India.

Tree Attacked.—Mango (*Mangifera indica*). Dehra Dun Plateau.

Fig. 90.—Entrance and exit holes ("shot-holes") of the Bamboo Beetle *Dinoderus pilifrons*, Lesne, in *Dendrocalamus strictus*. South India.

Larva.—Yellowish-white, corrugated, curved. Mouth parts brownish, mandibles black. Thoracic segments greatly enlarged, swollen, forming almost a hood over head anteriorly. Three pairs of thoracic legs, anterior pair three-jointed, robust and long; posterior pairs less stout. Abdominal segments not swollen, narrower than thoracic ones, forming almost a "waist" where they join thorax, but slightly broadening behind. Length, 3.2 mm.

Pupa.—Prothorax large, the head bent right over and under prothorax, the mouth parts lying pressed against the hind thoracic and anterior abdominal segments. Head and prothorax dirty white; the ten-jointed antennae and legs distinguishable. Abdominal segments yellow, wings white, bent round on underside of body. Length, 3 mm.

Life History.

This beetle has three, four, or more broods in the year, and these generations overlap to some extent. Eggs appear to be laid by the beetle in the cold weather in December or January, or perhaps in November, the colder months of the year being passed in the egg stage. The female tunnels into the bamboo for egg-laying purposes, and pairs with the male inside the bamboo. The larvae hatch out in March in North India, probably earlier in the hotter and damper parts of the country, and feed upon the woody tissue of the bamboo, mining up and down in the interior and converting the woody material into a mass of sawdust. When full-fed the grub eats out a little cradle in the woody tissue and pupates in this. On maturing the beetle either crawls out of the bamboo through one of the entrance-tunnels of the parents, which it may enlarge if necessary, or it tunnels out by the most direct way to the outside.

This first generation of the year issues from bamboos some time in May in North India and late in April in Calcutta; a second generation issues in July (June in Calcutta); a third early in September (August in Calcutta); a fourth in November (October in Calcutta), and a fifth in Calcutta and similar localities towards the end of November or first half of December.

D. pilifrons is the common bamboo-borer of the northern part of India. Series of experiments were carrried out on several occasions with bamboos cut in the forests of the United Provinces. Thousands of beetles were bred out, in every case proving to be *D. pilifrons*.

The work of this insect is very similar to that of its ofttimes companion or replacer *D. minutus*, the next species, and the damage done, etc., will be discussed under that insect.

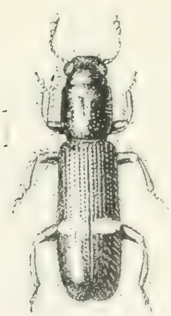
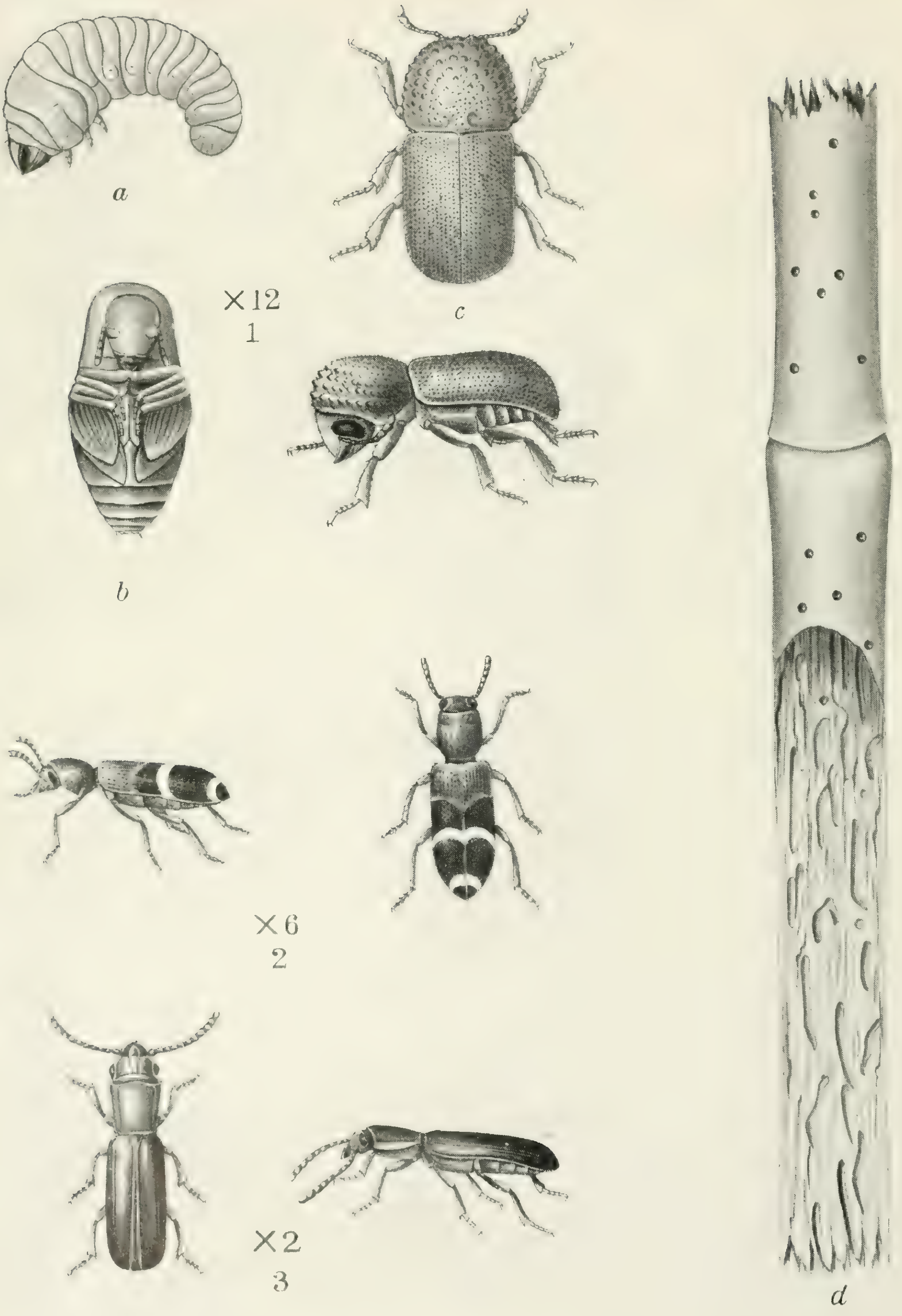


FIG. 91. *Tarsostenus univittatus*, Rossi. Dehra Dun.

Tarsostenus univittatus, Rossi (p. 188).—Elongate, narrow, rather flat. Black, shining; elytra crossed just above the middle by a transverse half-moon shaped band which does not quite reach suture. Head finely punctate. Prothorax rather flat, impressed medianly, the punctures larger than on head, but rather scattered. Elytra with sides parallel, apices separately rounded, pygidium exposed; the basal half impressed, with rather deep punctures arranged in longitudinal parallel rows; the apical half very finely punctate. Length, 7 mm. to 13 mm.

Predaceous Insects.

PLATE IX



1. *Dinoderus minutus*, Fabr.—*a*, larva ; *b*, pupa ; *c*, beetle ; *d*, bamboo showing entrance-holes on outside, and larval and beetle galleries inside. 2. *Tillus notatus*, Klug. ; 3. *Hectarthrum heros*, Fabr., both predaceous upon *Dinoderus minutus*. Calcutta, 1903.

Life History.—A specimen of this clerid beetle was taken from a thatched roof of a building in Dehra Dun badly infested by *Sinoxylon crassum* and *Dinoderus pilifrons*. The insect may be predaceous upon the *Dinoderus*.

Tillus notatus, described below, likewise attacks this insect. Also *Tribolium confusum* (p. 238).

Dinoderus minutus, Fabr.

(*The smaller Bamboo Shot-borer Beetle.*)

REFERENCES.—Fabr. *Syst. Ent.* p. 45 (1775); *substriatus*, Stephens, *Ill. Brit. Ent.* iii, p. 352 (1830); *siculus*, Baudi, *Berl. Ent. Zeit.* xvii, p. 336 (1873); *bifoveolatus*, Zoufal (*non* Wollaston), *Wien. Ent. Zeit.* xiii, p. 42 (1894); *Dinoderus* sp. *Ind. Mus. Notes*, i; Stebbing, *Ind. Mus. Notes*, vi p. 23 (1903); *Depart. Notes*, 172 (1903).

Habitat.—Bombay Presidency (Andrewes); Calcutta, Burma, Carin Cheba, 2,800 to 3,500 ft., Teinzo, Bhamo (Fea). Lesne states the species to be cosmopolitan in tropical regions. It is at times found in ports and large towns in temperate climes.

Trees Attacked.—Bamboo (*Dendrocalamus strictus*): Calcutta, etc.; *Bambusa* spp., *Smilax borbonica :* Ile de Réunion ; Lianas (Brazil).

Description.

Beetle.—Brown, shining, with black head and thorax, the bases of elytra lighter-coloured, occasionally almost reddish. The stiff hairs on the front clypeal region always few in number and very short. Antennae ten-jointed, the funiculus not fringed with hair ; the second joint of club less than one and a half times as wide as long. Teeth of anterior margin of prothorax more or less pointed, not set very close together, the middle ones most prominent ; sides posteriorly strongly and densely punctate, median foveoles well marked. Elytra set with short stiff reddish hairs, densest on the declivity ; thickly and densely punctate, punctures most prominent on basal portion ; suture of declivity not prominent. Length, 2.5 mm. to 3.5 mm. Pl. ix, fig. 1, *c*.

Larva.—Pale canary-yellow, opaque, curved, corrugated, the thoracic segments swollen, the prothorax tapering sharply anteriorly to head. Latter small, orange-brown with black mandibles, three pairs of longish three-jointed legs on thoracic segments, the lowest joints clothed anteriorly with scattered yellow bristly hairs, the legs ending in a claw. Body tapers posteriorly to a blunt rounded point. Length, 3 mm. to 3.75 mm. Pl. ix, fig. 1, *a*.

Pupa.—Resembles that of *pilifrons*, but is smaller. Pl. ix, fig. 1, *b*.

Life History.

Dinoderus minutus was for some time consistently confused with *D. pilifrons* in India, with the result that the literature connected with the two species became so indefinite that it was impossible to say what the real life histories of the insects were. *D. minutus* was known to infest bamboos, and it was thought to accompany *pilifrons* very often in this connection. The insect had also been reported as infesting other plants.

Two points would seem to have been established. The large series of beetles reared at Dehra Dun from bamboos cut in the Siwaliks and neighbouring United Provinces forests consisted entirely of *pilifrons*, whilst the hundreds of beetles bred from bamboos in Calcutta during the year 1903 were entirely *minutus*. *D. pilifrons* exists in Calcutta, as I took it on wood stacks of miscellaneous species of trees in the Botanical Gardens towards

the end of April. It is not, however, the common bamboo beetle of Calcutta, and was probably imported there in bamboos or other woody material cut in the North of India forests during the preceding cold weather.

The life history of *minutus* in Calcutta was worked out at the Indian Museum by myself between April and November 1903. The beetle and its grub attack the internal woody structure of the bamboo in a manner similar to that of *pilifrons*. *D. minutus*, however, passes through a greater number of generations in the year in the hotter moister climate of Bengal, the number of life-cycles being from five to seven, the generations overlapping to some extent.

Both male and female beetles tunnel their way into the bamboo, and after pairing the female lays its eggs in the interior, each beetle laying about twenty. From these eggs small white roundish dots of grubs issue within a few days of their being deposited. These tiny larvae burrow up and down in the interior of the bamboo, and reduce its structure to powder. About four weeks are spent in this stage, and the grubs then enlarge the ends of their burrows and change to pupae, which, after some eight days or so, turn into the beetles. On becoming mature the beetles bore their way out of the bamboos, and thus add further to the tunnels already made in them. On emergence the insects fly off to attack fresh bamboos, or they may bore into the one in which they have themselves matured. There are thus three separate forms of attack :—

(*a*) The female beetle bores into the interior of the bamboo and lays its eggs there. This is the first attack on the bamboo.

(*b*) From the eggs hatch out little grubs which feed upon the wood of the interior of the bamboo, and thus undermine its strength.

(*c*) The beetles on maturing from the grubs bore their way out of the bamboo.

The mature beetles issue either all from the same exit-hole or from one or two only, these being often the former entrance-holes of the mother beetles, which are considerably enlarged. Beetles of the new generation appear also to make use of these old holes to enter the bamboo to egg-lay, boring away from the old gallery when they have got inside. When bamboos are in lengths it will be found that the beetles tunnel in them parallel to the long axis and form galleries which open at one of the ends. The bamboo is thus often completely hollow in parts without there being much outward evidence of its having been badly attacked. This is more especially the case when the beetles have entered and left by the same holes made at one of the ends of the bamboo (cf. the lengths of bamboo shown in pl. ii). A feature which greatly adds to the insect's power of doing serious damage is to be found in the fact that in the warmer parts of the country it passes through at least five, and perhaps more, generations or life-cycles in the year. It

has been shown that the insect lays about twenty eggs, and therefore one female beetle may produce the following progeny in the year, on the supposition that only five generations are passed through :—

One Female Beetle.

1st generation	...	1 × 20 =	20 beetles, say half males and half females (the latter are, however, usually in excess of former).
2nd ,,	...	10 × 20 =	200 beetles, say half males and half females.
3rd ,,	...	100 × 20 =	2,000 ,, ,,
4th ,,	...	1,000 × 20 =	20,000 ,, ,,
5th ,,	...	10,000 × 20 =	200,000 ,, ,,

If there is a sixth generation the number of females increases to 2,000,000.

Taking only 50 per cent. of the fifth generation beetles as maturing and laying eggs, we still have 100,000 insects as the progeny of the one mother beetle in the spring. This great prolificness easily explains why bamboos suffer so greatly from the shot-borer's attacks throughout the country.

The result of my observations in Calcutta showed me that at least five generations of the beetles issued between the last week in April and the end of October as follows :—

The first taking about seven weeks, from end of April to the third week in June, to run through all its stages; the second about four to five weeks, from the third week in June to near the end of July; the third four weeks, from the end of July to the beginning of September; the fourth less than four weeks, from first week in September to end of the month; the fifth from end of September to end of October. It is probable that many of the beetles of this generation were caught and killed off by the cold snap experienced towards the end of the month.

I have detailed at length in three pamphlets * dealing with this bamboo-borer the series of experiments carried out by myself at the Indian Museum, Calcutta, during my tenure of the Superintendentship of that Institution in 1903. As described in the monographs in question my experiments were inaugurated to enable me to advise the Superintendent of the Government Telegraph Workshops (Mr. Williams) as to the economic value of experiments he was conducting with a view to protecting from the attacks of the beetle bamboos which he was converting into poles

* (1) A Note on the Preservation of Bamboos from the Attacks of the Bamboo Beetle or Shot-borer, *App. Series Ind. Forester*, xxix, no. 12 (1903); (2) Ibid. 2nd edition, revised and enlarged, *Forest Pamphlet* no. 15, Supt. Govt. Printing, Calcutta (1910); (3) A Further Note on the Preservation of Bamboos from the Attacks of the Bamboo Beetle or Shot-borer, *Ind. Forester*, vol. xxxi, p. 249 (1905).

for use as a field telegraph during the approaching Tibet Mission. It was imperative that the bamboos so employed should remain immune to the attacks of the beetles, which would otherwise reduce them to powder within a comparatively short period, and long ere they reached an elevation where the temperature would either kill the beetles or (more probable) so lower their vitality and that of the grubs as to reduce very considerably their activity.

The experiments carried out consisted in placing in beetle-proof boxes a number of lengths of infested bamboo taken from the workshops either untreated or thoroughly soaked in water for several days, soaked in water and then in a solution of copper sulphate, and lastly soaked in water, copper sulphate, and Rangoon oil, the latter from twenty-four to forty-eight hours, and watching the effects of the beetles' attacks on them. Lengths of bamboo thoroughly soaked in water, copper sulphate, and Rangoon oil were also placed amongst lengths of badly infested bamboos in the open, with a view to further testing their immunity from attack.

The following deductions may, I think, be considered as established by the above experiments :—

Results of Treatment.

(1) That neither the five days in water nor that followed by a further five days in $CuSO_4$ are of any use as a protection against the beetles. It is true that Experiments II and III seemed at first to prove that these soakings were effective, since the bamboos in these boxes remained unattacked. I attribute this, however, solely to the fact that the pieces of bamboos, selected at haphazard in the Telegraph Workshops, and placed in the closed boxes in April when the beetles were egg-laying, did not happen to have had eggs deposited in them, and consequently when they were placed in the beetle-proof boxes and protected against any future depositions of eggs in them they showed no attacks. All the subsequent experiments with these classes of treatment showed that they afford no protection against the beetles.

(2) That the bamboos which had gone through all the stages of the treatment and had received a proper soaking in the oil tank remained unattacked, and in addition were proof against further attacks by the beetles.

(3) That at least five generations of these beetles issued between the last week in April and the end of October, as detailed above.

(4) That bamboos cut in the forests between December and February can, even if not treated till two or three months have elapsed since cutting (by which time it is probable that many of them will contain eggs), be preserved by the oil treatment from further attacks of the beetle-borer. Bamboos unprotected by the oil treatment are tunnelled into by the April, June, July, September, and October generations of beetles, each of which attacks means their subsequent riddling by the larvae arising from the eggs laid by the beetles.

(5) That the oil treatment therefore considerably prolongs the period of usefulness of the bamboo, this period being, as far as the experiments at present show, at least a year.

Recommendations.

(*a*) I am inclined to recommend that the soaking for five days in water should be continued, since a thick, shiny, gelatinous substance exudes from the bamboos during this process, and this exudation probably enables the bamboo to absorb a larger quantity of oil than would be otherwise the case.

(*b*) That the soaking in the copper sulphate solution be discontinued, since the experiments have shown it to have no preservative effect against the beetles.

(*c*) That the bamboos be allowed to dry in a covered shed for several days after the water process.

(*d*) That, after drying, the bamboos be soaked for forty-eight hours in common Rangoon oil.

Cost.

The Superintendent of the Telegraph Workshops informed me that the cost of the treatment as carried through by him, i.e. five days in water, five days in $CuSO_4$, followed by several days' drying and then two separate soakings (at an interval of a couple of months) of twenty-four hours each in Rangoon oil, amounted to Rs. 3 to Rs. 5 per 100 6-ft. lengths, or 6.3 pies per length. This includes the labour.

Omitting the $CuSO_4$ treatment and a second soaking in the oil, together with the additional handling involved, should effect a saving in this price, although of course the longer period of soaking in oil will enable the bamboos to absorb more of this commodity than they would in the shorter one of twenty-four hours only.

Summary of Observations on the Treatment made in 1905.

In 1905 a visit was paid to the Telegraph Workshops with the object of ascertaining how the treated bamboos which had been converted into telegraph posts had fared, and especially how those which had been sent on service with the Tibet Expedition had faced the ordeal and in what condition they had returned.

At the workshops I found that it was easy to trace the history of the bamboos treated in 1903, all of which had been converted into field telegraph posts, a stage further in their career.

The evidence collected both in the use of the posts in the field and, equally important, by their storage in an open shed in the workshop yard in Calcutta without any special protection being afforded to them points to the wonderful efficacy of the oil treatment.

Some of the bamboos converted in 1903 and sent up that year for service with the Tibet Mission were returned to store in Calcutta about the beginning of 1905, and Mr. L. Truniger, C.I.E., who was in charge of the Field Telegraph with the mission, has stated that they had fully answered expectations. The returned posts were inspected by the writer in the yard at Calcutta towards the end of March 1905. Although it was two and a half years since they were cut in the forests of Upper India, and close upon two years since they were treated with the oil, they showed no trace of attacks by the *Dinoderus* bamboo beetle. It may be contended, and justly, that throughout 1904 these posts had been at an altitude greatly above that at which either of the shot-borer beetles could or do live, and that they were thus safe from their attacks. This was so, but the same argument does not hold good when we come to consider those converted bamboos which remained throughout the year in store in Calcutta. An inspection of these has shown that they had remained equally immune from the pest. Those who use it are aware how short is the life, economically, of the bamboo after it has been cut. To the Public Works,

Military Works, Forest Department, and many other minor departments it means a constantly recurring annual expenditure on petty works; and many also know the difficulties which stand in the path of the lance, the tent-pegging, and hog-spear purveyor. The results that attended the treatment of the 9,000 bamboos in 1903 are well worthy of the consideration of all of these, for on present observations it has been shown that the impregnation with the oil leaves the bamboo strong and serviceable two and a half years after it has been cut. That the Telegraph Department has the fullest confidence in a discovery the full credit of which chiefly belongs to it is borne out by the fact that an additional 30,000 bamboos were put through the treatment and converted into field telegraph posts in 1905. The treatment consists in first soaking the bamboos in water for five days (this is very necessary, for reasons previously given), allowing them to dry for several days, and then resoaking them in the Rangoon oil (crude petroleum), this latter, as used in the workshops, having the consistency of treacle.

That the use of the bamboo as a field telegraph and telephone post has a great future before it was proved by the Japanese in the Russo-Japanese campaign. The following note upon the subject appeared in the Allahabad *Pioneer:* "Every general of brigade in the field is 'at the end of a wire' which his divisional commander controls, and the generals of divisions are in touch by telegraph or telephone with the corps commander. The engineers run wires after the columns with marvellous rapidity. Firing is heard somewhere at the front. A detachment of engineers emerges from head-quarters, pack ponies carrying bundles of light bamboo poles, while coolies and carts follow them with coils of slender copper wire. The poles, which have pointed ends, are quickly planted, the wire spreads out as fast as men can uncoil it, and a field telephone is at work." As having a bearing upon the experiments and results attained in India, Mr. Y. Hara, Chief of the Japanese Forest Bureau, was addressed with the object of ascertaining whether the bamboo field-posts used by his countrymen were subjected to any treatment. His reply would seem to show that in this matter Japan is in the position occupied by India before the discovery of the oil treatment. He wrote: "In answer to your inquiries with regard to protection of our bamboos, I would state that although the method of preserving bamboos in the field is not well known, there are three processes of treatment generally adopted by our people—

(1) The season of cutting—September and October.
(2) The fumigation in sulphur.
(3) Application of both of these processes."

The Treated Bamboos in 1909.

In reply to a reference on the subject the Superintendent of the Telegraph Workshops wrote as follows on 20 September 1909: "In 1904 some 15,000 posts were made (i.e. soaked in water and Rangoon oil), the majority of which were afterwards stored in a heap in an open shed in this yard until quite recently. It was found that wiping them over once a year with earth oil gave absolute protection from the borer."

Now, the yard in which these bamboos were stacked may be said to be situated in the heart of an area infested by the beetle borers. In the neighbourhood are native depots containing hundreds of thousands of bamboos in which the beetles are to be found in millions.

I think no further argument in favour of the enormous value and efficacy of the water and oil treatment can be required than is afforded by these 15,000 bamboos which have remained immune to the beetle-attacks for a period of five years and are as good and sound to-day as they were when they were treated.

Predaceous Insects.

1. **Tillus notatus**, Klug. (p. 186).—The beetles are slim and slight in build, and exactly fit the gallery of the *Dinoderus minutus* beetle. The head, antennae, and margin of prothorax are black, shining ; three basal joints of antennae red-yellow, rest black. Rest of prothorax dark orange-red ; basal fourth of elytra orange, rest yellow, the apices black ; a transverse black band, broadest on outside margin, crosses the elytra medianly, and a broader one occupies the major part of the apical half. Under-surface yellowish, abdomen black. Head and prothorax finely punctate ; elytra coarsely striate-punctate in basal half, finely punctate apically. Length, 8 mm. to 13 mm. Pl. ix, fig. 2, shows the beetle.

Pupa.—Elongate, narrow. Yellowish-white. The wings and legs pressed against the chest, the antennae to the sides. I have taken several pupae from the larval galleries of *Dinoderus minutus*. They exactly fit the galleries, and wriggle about a good deal when disturbed or removed.

Life History.—This beetle is predaceous upon the *Dinoderus minutus* larvae and pupae, and perhaps beetles. Whilst engaged in investigating the attacks of this bostrychid in bamboos in Calcutta in 1903 I first discovered this *Tillus* in the galleries of the *Dinoderus* inside the bamboos. Towards the end of May I cut out a number of the beetles which had all entered the tunnels, whose circumference their bodies exactly fit, to prey upon the *Dinoderus*.

I first took beetles on 25, 28, and 30 May. They lie up in the longitudinal galleries bored by the beetles and larvae. The *Tillus* is extremely active, and runs and flies well.

During May and a part of June I made some experiments with this predator with the object of discovering whether it attacked the beetles or larvae for its food. In the cases where the beetles only were placed in a box with the *Tillus* they remained apparently untouched by the latter. Between 26 and 31 May not one beetle was attacked. On 1 June I placed some living *Dinoderus* larvae and pupae in the box, and these were at once attacked by the *Tillus*. In the case of the larva the clerid beetle invariably attacked it at the posterior end, slightly to one side on the tenth or eleventh segment, and appeared to suck out its contents, first firmly clasping it with its mandibles.

Now, *Thanasimus himalayensis* (*vide* p. 508) devours the scolytid beetles it preys upon outside the tree, and does not feed upon the larvae or pupae or enter the tree. It would appear probable, therefore, that the *Tillus* does not attack the *Dinoderus* beetles, the hard exterior chitin of which its small mandibles do not appear powerful enough to pierce through, but enters through the beetles' entrance-holes into the bamboo, and then pushes its way through the wood-dust and excreta in the larval galleries inside in search of the larvae and pupae.

The clerid beetle would appear to pass through as many generations in the year as its host. Its larvae evidently feed predaceously on the bostrychid ones in the bamboo, and pupate in their galleries.

2. **Hectarthrum heros**, Fabr. (p. 116).—This black predaceous beetle feeds in both its larval and beetle state on the *Dinoderus*.

3. **Tribolium castaneum**, Herbst. (p. 239).—I took this small brown *Tribolium* from the galleries of *Dinoderus minutus* in the bamboos kept under observation in Calcutta in 1903. It feeds semi-predaceously upon the grubs of the *Dinoderus* beetles. I bred out the beetles late in May, and know nothing further about its life history.

THE EFFECT OF THE MOON'S PHASES ON THE PERIOD OF FELLING BAMBOOS.*

It has been a matter of common knowledge for some decades past amongst those who have had any connection with the cutting and export of bamboos in India, and to a certain extent of poles as well, that the natives have long held a superstition that neither the one nor the other should be felled when the moon is full; they argue that the sap is then very abundant, and unless the bamboos are well soaked in a tank and subsequently preserved with plenty of smoke they will be rapidly destroyed by boring insects (*cootee*). The most serious of these pests are the bostrichid beetles *Dinoderus pilifrons* and *D. minutus*. This curious theory is held so commonly throughout the country that I have been for some years past endeavouring to ascertain the causes which have given rise to it, the reasons upon which it is based, and whether any scientific facts can be adduced in its favour.

One of the explanations put forward is to the effect that the *cootee*, like many other wood-boring insects, prefers to lay its eggs in wood which has commenced to wither and which consequently no longer has a healthy flow of sap to interfere with the insect in its burrow. This being so, the time immediately after the bamboo is cut down would be the most likely one for it to be attacked.

It seems to be a generally received idea that soaking the bamboo, as also other timber, in water for a considerable time immediately after it has been felled, makes it less liable than it would otherwise be to suffer from boring beetles of all kinds. It is supposed that not only does the water prevent the beetles laying their eggs during the time the bamboo or wood is immersed in it, but that it also drowns insects already at work and dissolves much of the nutritive matter on which they otherwise feed.

That bamboos, once sickly and dying or dead, suffer largely from the attacks of beetles must be obvious to the most superficial observer who glances over a bamboo clump or examines furniture, houses, fences, etc., entirely or partially built of bamboos. We are not here concerned, however, with this aspect of the question; our purpose being to discuss the information at present available as to the effect the felling of bamboos and posts at different phases of the moon has upon their subsequent immunity or otherwise from the attacks of boring pests.

In their *Forest Proceedings* † the Madras Board suggested in 1898 that investigations should be carried out in this matter; and the experiments initiated as a result, although made in a few divisions in Madras only and in a manner which leaves room for improvement, are of very considerable interest as serving to show that the so-termed superstition of the natives of the country has perhaps some substratum of solid fact to rest upon.

Before detailing the various experiments made in this country I will first refer to a paper read by Ernest R. Woakes before the American Institute of Mining Engineers ‡ in which the

* I published this note in the *Indian Forester*, November 1906 (vol. xxxii).

† Board's Resolution, *Forest Proceedings* no. 255, dated 24 June 1898.

‡ This paper was reprinted in the *Tropical Agriculturist* for October 1899.

author stated that in South America (Columbia) *not only bamboos but all trees* are felled during the waning moon only, and not during its increasing phases. It would appear that in that country the effect of the moon's phases is treated as an accepted fact. Mr. Woakes states from his own experience that he has often seen the sap running out of stumps during the increasing moon which were absolutely dry during the waning moon.

In a letter * on the subject Mr. A. W. Peet, Acting Conservator of Forests, Central Circle, Madras Presidency, made the following remarks in 1899 :—

" As regards bamboos I expect that the question of durability depends to a great extent on the question of sap, but the problem seems to be complicated by the doubt whether we are to reckon with the effect of the moon's phases, as well as with the period of the year at which they are felled. I doubt if even the borer can subsist without the elements of the sap on which to feed, and the principle of soaking bamboos is, I think, useful chiefly because it tends to dissolve the fermenting constituents. Heating and smoking bamboos are additional precautions generally adopted.

" The point, however, which I wish to emphasize here is whether we should not primarily consider the period of the year at which bamboos are felled, and only secondarily the period of the month. There seem good grounds for paying attention to the latter, if we can only determine definitely the number of days in a month in which bamboos can be felled with confidence, and I will revert to this point. However, I think that unless strong evidence is adduced to the contrary, we shall treat bamboos like other vegetation and assume that the period when the sap is most vigorous, and therefore the fear of fermentation most pronounced, is in the spring, and that this season should be avoided for felling if durability is of importance: and it may even be a question whether the root stocks will not be more injured during this period.

" In order to test this presumption I lately questioned a bamboo contractor, without giving him any leading questions, and he told me that he believed that there was something in the waning moon theory, but that he had come to the clear conclusion that bamboos felled during March and up to the end of July had less durability than those felled during the other months of the year.

" As regards the phases of the moon a hill man told me that he considered that bamboos might be felled safely during the seven days before new moon, and the seven days after ; but on being pressed as to what he considered absolutely the best period he said during the seven days before. His theory of the seven days after would seem to conflict with Mr. Woakes's theory."

The experiments carried out in Madras, although they cannot be considered to have been as definite as is desirable, are still of very considerable interest. They were initiated in four separate localities, viz., the Nilgiris, North Coimbatore, South Coimbatore, and South Malabar, and the following summarizes the observations made :—

NILGIRIS, 30 *June* 1899.—Bamboos were cut in all the ranges except Ootacamund a few days before and a few days after new moon and full moon, and kept separate from each other. Some were smoked and others were soaked in water. It was found that bamboos cut on dark nights and immediately soaked or smoked for a period of two months were not attacked by the borers. From the experiments conducted in the various ranges it was observed that bamboos felled during moonlight nights were more severely attacked than those felled during dark ones, and that soaked bamboos fared much better than unsoaked ones. As a result of the experiments the recommendation was made that as soon as felled the bamboos should be fully immersed in water for some time or properly smoked in a shed, or otherwise they were liable to be attacked by the borers.

As I have shown, however, in my previous papers on the preservation of bamboos from the borers, neither immersion in water nor smoking is to be depended upon as a safe preventive.

* No. 454, dated Madras, 25 October 1899, to the Commissioners of Land Revenue Madras.

NORTH COIMBATORE, 24 *August* 1899.—A series of experiments were conducted in the Satyamangalam Depot at the foot of the Ootacamund Hills. During each week of the month one head load of twenty-five bamboos of two kinds (dry solid bamboos known as "Karanai" and green hollow bamboos known as "Varar") were set aside and marked. It was observed that dry bamboos appeared to withstand the attacks of the borers better than the green. In every case the insects attacked the bamboos in the inside of the bundle first, i.e. those not exposed to light. This is a general rule amongst these boring beetles, who very generally, although by no means always, attack in the shade in preference to strong light.

As a result of the experiments conducted here it was held that the phases of the moon had no effect on the felling season. It was noted, however, that bamboos exposed to light and air are less liable to attack than those not so exposed.

SOUTH COIMBATORE, 18 *February* 1899 *and* 1 *November* 1899.—A series of experiments were made on two occasions at Mount Stuart, one from 2 August to 1 September 1898, and the second from 10 March to 12 April 1899. On each occasion ten large bamboos (*Bambusa arundinacea*) and ten small (*Dendrocalamus strictus*) were cut daily. Each bundle of ten was labelled, and the bundles were all laid out in a row. Those cut on the first occasion were examined one by one on 2 February 1899, with the result that the influence of the different phases of the moon did not appear to have any bearing upon the presence or absence of the borers. On the second occasion one-half of the length of each bundle was covered with mats, the other being left uncovered. This was done in order to observe the effects of shade as a protective influence or otherwise to the bamboos. The bamboos so treated were examined at the beginning of October. It was found that the portions of the bamboos covered over by the mats had at work in them double the number of boring insects that were to be found in the uncovered portions. Thus the insects attacked bamboos stacked in the shade twice as heavily as those stacked under the full rays of the sun.

The following were the percentages of attack observed in the case of the two species of bamboos experimented with :—

Bamboo.	Percentage attacked by borers on the first occasion.	Percentage attacked by borers on the second occasion.
Bambusa arundinacea	50.53	34.33
Dendrocalamus strictus	39.47	41.66

It will be noted from the above that the percentage of attack in the case of *Bambusa arundinacea* varies considerably, being much higher in the case of the bamboos cut in August than in the case of those cut in March-April. In the case of *Dendrocalamus strictus*, however, the percentage of attack differs but little, the increase inclining to those cut in the spring months of the year. To be conclusive, further experiments with a larger number of bamboos should be carried out in this Division.

SOUTH MALABAR, 4 *October* 1899.—A series of experiments were made from 2 August 1898 to 7 April 1899, both at the full moon and new moon periods. On each occasion a bundle of twenty-five bamboos was soaked in mud and water, whilst a second bundle was merely stacked. The experiments seemed to show that neither the soaking nor felling at any particular phase of the moon had any marked effect in preserving the bamboos from the attacks of the borers. It was noted, however, that the bamboos felled during the months of January, February, and March were not attacked by the borers, stacked bamboos felled at other periods being invariably attacked.

The above summarizes the experiments as far as they appear to have been carried in Madras. They support and confirm observations of my own on two points :—

(*a*) That the cold-weather months are the best ones in which to fell, although felling at this season does not guarantee immunity to the bamboos from the attacks of the borers.

(*b*) That bamboos stacked in the shade or covered up in such a manner as still to allow of the beetles getting at them will be more severely attacked than those stacked in the open.

The question as to the best time in the month to fell requires a more detailed series of experiments to be carried out before we can finally say that the belief so commonly held in India is a mere superstition. It will be noted that in the Madras experiments the bamboos kept under observation were either *stacked together* or the bundles were placed in rows *adjacent to one another*. Now this procedure greatly detracted from the value of the experiments carried out, since it is possible, if not probable, that the bamboos cut at a certain period of the moon's phases first attracted the beetles which, appearing in numbers too great to find accommodation in the bamboos in the condition they preferred, overflowed on to and attacked neighbouring bundles which otherwise might have escaped. If the experiments are to be reliable, it is necessary to cut bamboos at different periods in the month from the same clump or forest and to stack the lots cut on different dates at considerable distances apart, so that the danger of the lot in the condition preferred by the beetles attracting the insects to the others will cease to exist.

A study of the life-history of these insects will show that the beetles do not appear on the wing in December and January at least, in the more southern portion of the Continent, and for an even longer interval in the northern portions. This therefore accounts to some extent for the immunity of bamboos from attack at this period.

Mr. A. M. Smith, of the Peradeniya Botanical Gardens, Ceylon, in discussing the above paper, appears to hold the theory that the amount of moisture present in the atmosphere at the period of felling may be intimately connected with the question. He thinks that it is possible that the atmosphere may contain more moisture in it on dark nights than on moonlight ones. In fact, that the moon may have something to do with the matter, since bamboos contain a far greater amount of moisture on dark moist nights than on drier ones, when more of it is transpired from the leaves.

In order to settle the question of the effect of the phases of the moon on the period of felling, series of experiments are required on the following lines :—

(*a*) Bundles of bamboos to be cut weekly, each week's felling to be numbered and stacked *separately* as far apart as possible (at least a mile).

(*b*) The phase of the moon at the period of felling to be accurately noted.

(*c*) Particulars as to locality, elevation, etc., to be noted for each bundle cut.

(*d*) The bundles to be inspected *weekly* and rough notes as to the percentage of each bamboo attacked to be noted down for each week.

(*e*) The species of bamboo experimented with to be accurately noted.

(*f*) My own theory at present is that bamboos felled *during November and the first half of December* and *immediately piled* or *stacked in the open* will not be attacked by the borers. Experiments carried out in different parts of the country are necessary to prove this.

Dinoderus brevis, Horn.

REFERENCE.—Horn, *Proc. Am. Phil. Soc.* xvii, 550 (1878).

Habitat.—Dehra Dun, North India: Calcutta. Also reported from Teinzo and Rangoon, Burma, Indo-China, Philippines.

Trees Attacked.—Bamboo (*Dendrocalamus strictus*): Dehra Dun and Calcutta; ? Sál (*Shorea robusta*): Dehra Dun.

Description. **Beetle.**—Greatly resembles *D. minutus*. Differs in its more convex form and eleven-jointed antennae. The dorsal punctures of the elytra are less dense than in *minutus*. The erect hairs on the apical declivity of the elytra less dense and slightly longer, cylindrical or sub-claviform, not pointed. In the female the two median teeth of the marginal row of the rasp-like anterior portion of the prothorax are larger, wider apart, and more prominent than in the male.

Life History. I have taken this beetle in July infesting bamboos in the roofs of bungalows in Dehra Dun, and also a few individuals from bamboos at the Indian Museum in Calcutta, in October 1903. The life history of the insect is very similar, so far as my present observations have been carried, to that of *D. minutus*.

I think it is probable that the insect also infests sál posts used in bungalow roofs in Dehra Dun.

L. Fea took specimens of this insect at Teinzo in Burma in May, and in Rangoon in May–July. Horn obtained a specimen which he saw issue from the bamboo handle of a Japanese fan.

II. BOSTRYCHINAE.

Tarsi as long as, or longer than, the tibiae, last joint shorter than the rest of the joints together; prothorax strongly tuberculate, the anterior margin with the lateral teeth more prominent than the median ones. This division contains the groups:

Bostrychines, including the genera *Schistoceros*, *Heterobostrychus*, *Bostrychopsis*, *Xylopertha*, *Xylodectes*, and *Xylothrips*;

Apatines, one species of the genus *Apate;*

Sinoxylonines, including the important genus *Sinoxylon*, which contains the wood-borers *S. crassum* and *S. anale*.

Schistoceros (Caenophrada).

Schistoceros (Caenophrada) anobioides, Waterhouse.

References.—Waterhouse, *Ann. Nat. Hist.* i, 350 (female), sub *Caenophrada* (1898); Lesne, *Ann. Belg.* p. 18 (male) (1897); id. *Ann. Fr.* p. 519 (1898); *Bostrychus jesuita*, Stebbing, *Inj. Ins. Ind. For.* p. 42 (1899); *Bostrychopsis jesuita*, Stebbing, *Ind. Mus. Notes*, vi, 35 (1903).

Habitat.—Singbhum, Chota Nagpur, Calcutta. Also reported from Dinapur, Hazaribagh in Bengal, Saugor, Belgaum, Kanara, Sind, Madras, Burma, and Ceylon.

Trees Attacked.—Sál (*Shorea robusta*): Singbhum; Guava (*Psidium guava*): Hazaribagh (*Ind. Mus. Notes*).

Beetle.—Of considerable size; dark brown to black; anterior edge of the prothorax covered with a bright red pubescence; under-surface covered with a dense rufous pubescence. Front of head very finely punctured. Prothorax not as wide as long, and markedly narrower in front, rounded on sides and at the posterior angles; covered posteriorly with imbricate scales (♂) or flat granulations (♀). Apical declivity of elytra with two marginal tubercles on each side, less marked in female, in which the elytra occasionally develop rasp-like prominences between the punctures; elytra in both sexes covered with a very fine and short rufous pubescence. Length, 12 mm. to 18 mm.

Description.

FIG. 92. *Schistoceros anobioides*, Waterhouse. India.

Life History.

This bostrychid is a common insect in Singbhum, and indeed throughout Chota Nagpur, where it tunnels in company with *Sinoxylon anale* into sál timber. In 1895–7 I noticed that the green sál beams, rafters, and other materials used in the construction of the new rest-houses being built in the forests were very seriously riddled by these insects. The beetle bores into the timber to oviposit, the grubs eating out ramifying galleries in the heart of the wood, and pupating at the end of them when full-grown. The beetles, when mature, either leave the tree by a hole tunnelled out by a companion, or tunnel one to the outside for themselves.

Observations made during 1895–7 showed that in Singbhum the insects commence work early in March, and they, or their grubs, are to be heard operating in the wooden beams, etc., of the bungalows from that month to the beginning of the cold weather. Under their operations, tables, chairs, and floors were constantly covered with particles or little mounds of sawdust dropping down from the roof. I noticed that most of the work was done in the early morning, evening, and during the night, the sounds ceasing and the insect resting during the heat of the day.

The beetle has been taken on the wing in Belgaum in March, and I have taken it between March and June in Chota Nagpur. There is probably more than one life-cycle in the year.

From an imperfect identification of this insect, I have previously alluded to it as *Bostrychopsis jesuita*. This latter is an Australian species, and it is improbable that it will be found in India.

Bostrychopsis.

Bostrychopsis parallela, Lesne.

REFERENCES.—Lesne, *Ann. Soc. Ent. Fr.* p. 534 (1898); *Bostrychus parallelus*, Lesne, *Ann. Soc. Ent. Fr.* p. 174 (1895). Stebbing, *Depart. Notes*, i, 174 (1902).

Habitat.—Raipur, Central Provinces (A. M. Long); Calcutta. Also reported from the Deccan, Bengal, Assam, Indo-China, Formosa, Sumatra, Philippines.

Trees Attacked.—Bamboo (*Dendrocalamus strictus*): Raipur; *Smilax* sp. (Guérin-Méneville).

FIG. 93. *Bostrychopsis parallela*, Lesne. Central Provinces.

Beetle.—♀ The front is finely and densely pubescent in the centre, and not gibbous; prothorax smaller than in ♂, nearly square or rounded; dorsal punctures of elytra well marked, becoming elongate near suture, and slightly denser on apical declivity.

Description.

♂ Three kinds of ♂ are found:

1. Normal heteromorphous ♂, anterior angles of prothorax prolonged into horns which are curved downwards and have a glabrous outer surface; apical declivity of elytra with four marginal costiform callosities.

2. A ♂ having a mixture of the female and male characters. The prothorax is without horns, the latter being replaced by two teeth; the elytra without marginal callosities.

3. The horns of prothorax are replaced by teeth, of which the inner one is often absent; the marginal callosities are present, more or less prominent.

Size of insect is variable, the length being from 6 mm. to 15 mm. Specimens from Raipur measured 9.13 mm.

Life History.

Specimens of this insect were sent to me in 1901 by the late Mr. A. M. Long, of the Indian Forest Service. He found them tunnelling into dead stacked bamboos (*D. strictus*), in the middle of June, in the Raipur forests. The beetles were taken from the interior wood-tissue, where the insect appeared to be engaged in egg-laying.

I have since taken the insect both in the Central Provinces and in Bengal. The eggs are laid in the wood-tissue of the bamboo, and the grubs, on hatching, feed on this wood, eating out irregular galleries which more or less coalesce. On maturing, the beetles leave the bamboo generally by one orifice, either the entrance-hole of the female beetle or one eaten out by the first beetle to mature.

Whilst acting as Superintendent of the Indian Museum in Calcutta, in 1903, a live specimen of a male was brought to me, taken in one of the streets in the middle of May.

The beetle often infests bamboos in the thatched roofs of bungalows, in company with the species of *Dinoderus* already described.

HETEROBOSTRYCHUS.

Articulations of antennal club without well-defined velvety patches. Prothorax narrower in front, slightly hollowed out medianly near anterior edge. The beetles tunnel into the timber of fallen and felled trees, and also into converted timber.

Heterobostrychus unicornis, Waterhouse.

REFERENCES.—Waterhouse, *Bostrychus unicornis*, *Ann. Mag. Nat. Hist.* 5th ser. iii, p. 361 (1879); Fairmaire, *Ann. Belg.* p. 539 (1893); Lesne, *Ann. Soc. Ent. Fr.* p. 558 (1898).

Habitat.—Goalpara, Assam. Also reported from Kanara (T. R. D. Bell), Calcutta, Madras, Rangoon, Andaman Islands.

Tree Attacked.—? Sál (*Shorea robusta*) or Bamboo (*Dendrocalamus strictus*). Kachugaon, Goalpara.

Beetle.—Long parallel; dark brown, with the femora slightly reddish and the antennal club rufous. Elytra glabrous.

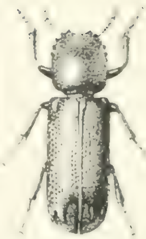


FIG. 94. *Heterobostrychus unicornis*, Waterhouse. Assam, etc.

Description. ♀ Front of head furnished with a tubercle, densely hairy and arc-shaped, which does not occupy a quarter of the inter-ocular space; finely and densely punctate. Prothorax as wide as long, greatest width in the middle, sides slightly rounded, anterior margin slightly indented, the indentations bounded on each side by an erect but not prominent tooth, posterior angles rounded; middle of posterior area covered with fine and dense flattened granulations. Elytral punctures well marked, but not in regular rows; apical declivity depressed on either side of suture, latter not prominent; apex of elytra slightly turned up. Intercoxal lobe of the mesosternum with a fine median keel. Abdominal segments finely and densely punctate, with a very fine pubescence.

♂ Head as in ♀. Elytra furnished on either side of the apical declivity with two tubercles, the outer simple, the inner larger and prolonged into a robust horn, curved inwards. Length, $9\frac{1}{2}$ mm. to $11\frac{1}{2}$ mm.

Life History. I took a male and female of this insect in the bungalow at Kachugaon, in Goalpara, Assam, on 23 May 1906, at night. I was of opinion that they had come either from the sál or the bamboos of which the bungalow was constructed. Both the sál and bamboos were pitted with the circular entrance and exit holes of wood-boring insects. The insect has been taken by Mr. T. R. D. Bell, of the Indian Forest Service, in Kanara, in the Bombay Presidency.

Heterobostrychus pileatus, Lesne.

REFERENCE.—Lesne, *Ann. Soc. Ent. Fr.* p. 559 (1898).

Habitat.—Singbhum, Chota Nagpur. Also reported from Kanara, Bombay Presidency, Cochin, and Tharrawaddy, Burma; Seven Pagodas, Tonkin.

Tree Attacked.—Sál (*Shorea robusta*). Singbhum.

Beetle.—♀ Very similar to *unicornis*. The frontal tubercle occupies transversely more than a third of the interocular space, and is much larger than in *unicornis*. The prothorax is longer than wide, widest behind the middle, narrower than in *unicornis*. Anterior angles less well defined, posterior angles more widely curved.

Description.

♂ Heteromorphous, head and prothorax larger than in ♀. Front simple, smooth, shining. Anterior angle of prothorax furnished with a prominent hook. The lower marginal tubercle of apical declivity of the elytra only slightly developed, the upper tubercle larger, prolonged into a horned prominence curved inwards and downwards. In the homeomorphous ♂ the front of head is similar to that of ♀, whilst the prominent hook of the anterior angle of prothorax is replaced by a simple upturned tooth. Length, 9–11 mm.

Life History. This insect has been taken in the Singbhum forests in Chota Nagpur, where it was found tunnelling into the sál poles and beams of which the forest rest-houses are constructed. The only individuals I obtained were taken in May 1897, at which time the insect appeared to be issuing from the timber for pairing purposes.

The life history is, doubtless, somewhat similar in character to that of *Schistoceros anobioides*, already briefly described.

Heterobostrychus aequalis, Waterhouse.

REFERENCES.—Waterhouse, *Proc. Zool. Soc. Lond.* p. 215, pl. xvi, fig. 3 (2) (♀) (1884); *uncipennis*, Lesne, *Ann. Soc. Ent. Fr.* p. 173 (♂ ♀) (1895); ? *papuensis*, MacLeay, *Proc. Linn. Soc. N.S.W.*, 2nd ser. p. 154 (♀) (1886); *Bostrychus aequalis*, *I. M. N.* v, 1, 34, pl. iii, fig. 7; Lesne, *Ann. Fr.* 560 (1898).

Habitat.—Dehra Dun, North India; Calcutta; Calicut, Madras (Thurston). Also reported from Sutlej, environs of Simla, environs of Chakrata (A. J. Gibson), British Bhutan; Maria Basti; Bhamo; Tharrawaddy.

Trees Attacked.—Sál (*Shorea robusta*): Dehra Dun; Semul (*Bombax malabaricum*): Calicut; *Poinciana elata*: Calcutta (I. H. Burkhill).

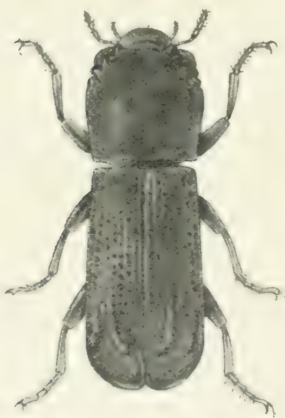


FIG. 95.—*Heterobostrychus aequalis*, Waterhouse. × 5. India and Burma.

Description.

Beetle.—Parallel, very slightly depressed, dark brown, often rufous-glabrous. Front of head similar in both sexes, rasp-like, without the tubercle present in above-described species; pubescence short and not thick. Prothorax with posterior angles often lobed, and posterior surface showing deep-impressed punctures, the disk with a more or less defined sculpture resembling imbricate scales. Elytra strongly and densely punctate, the punctures arranged in fairly regular rows of striae; punctation of apical declivity variable; apical margin turned up with a thickened border laterally, and with marginal tubercles, the inner of which may be hooked. Abdomen with a very dense punctation, rasp-like. Second tarsal joint of hind legs much shorter than the last. Length, 6–13 mm. Figs. 88, 95.

Variations occur in size and in the elytral teeth and callosities in the various forms of the males and females.

Larva.—White, curved, constricted posteriorly, with a brownish-black head, and three pairs of jointed legs on the thoracic segments, the abdominal segments corrugated.

Life History.

In the year 1898 some specimens of this insect were forwarded to the Superintendent of the Indian Museum, Calcutta, by Mr. Edgar Thurston, C.I.E., Superintendent of the Central Museum, Madras, with the information that they committed a good deal of damage by tunnelling into semul (*Bombax malabaricum*) timber at Calicut. As this timber was converted into tea-box planking (as is the case also in Assam), the destruction committed was of considerable importance. The adult beetle is found on the wing at Calicut in May–June.

Between the years 1902 and 1909 I took this insect commonly in Dehra Dun in July. The insect tunnels into sál timber in this locality, and is a common pest in the sál rafters of the thatched bungalows in the station. Every July between the years 1905 and 1909 specimens were taken in my thatched office in the grounds of Sikander Hall, where they issued from the sál timber in the roof. I also took individuals in August and September,

but have not definitely ascertained whether the insect passes through more than one generation in the year. The insect oviposits in the timber, the grubs eating out irregular galleries in the wood, and, when numerous, gradually reducing the latter to powder. They are commonly associated with one or more species of *Sinoxylon* in this attack.

The beetle was sent to me from the Economic Section of the Indian Museum in Calcutta by Mr. I. H. Burkhill, Officiating Reporter on Economic Products, in September 1905, with the information that it had been taken issuing from specimens of *Poinciana elata* timber (origin unknown) in the museum. Whilst acting as Superintendent of the Museum in 1903 I took the insect on the wing in the museum compound in June.

In 1908 Mr. A. J. Gibson, Imperial Forest Economist at the Research Institute, Dehra Dun, obtained specimens of the beetle in the environs of Chakrata, in Jaunsar.

Heterobostrychus hamatipennis, Lesne.

REFERENCES.—Lesne, *Ann. Soc. Ent. Fr.* p. 873 (♂ ♀) (1895); id. *Ann. Fr.* p. 562 (1898); *nipponensis* Lewis, *Ann. Nat. Hist.* ser. 6, vol. xvii, p. 339 (♂) (1896).

Habitat.—Kumaun Terai. Also reported from the Jhelum Valley; Sikkim; British Bhutan; Maria Basti; Sylhet; Ceylon.

Tree Attacked.—*Acacia catechu.* Jaula Sál, Kumaun.

Description.

Beetle.—Parallel, fairly large, robust, dark brown, with femora reddish at times; upper surface covered with a rufous pubescence, very short and sparse, denser near the anterior edge of the prothorax and in the ♂, on the apical declivity of the elytra, which often appears as if covered with a yellowish pulverescence; the pubescence on the scutellum is dense, and often appears as a well-marked light-coloured blotch. Ventral pubescence less short and more abundant than dorsally. Head large, the profile of the upper part forming a regular curve in both sexes: front not depressed, punctate, or rasp-like. Posterior angles of the prothorax straight or obtuse; sculpture of posterior surface fairly large, rasp-like, consisting of scaloidal tubercles, more prominent in the ♀. Apical edge of the elytra not reflexed; the punctures well marked, dense, and arranged in regular series.

♀ Eyes larger; anterior angles of the prothorax furnished with only one large erect tooth; apical declivity of elytra with a marginal callosity on either side.

♂ Anterior angles of the prothorax prolonged into upturned horns; posterior surface covered with scales medianly; apical declivity less strongly and less densely punctate than dorsal surface of elytra, and has on each side a marginal sub-cylindrical apophysis obliquely truncate on top. Length, 9 mm. to $15\frac{1}{2}$ mm.

Life History.

I found this beetle in April boring into the wood and large branches of khair (*Acacia catechu*) trees felled in the Jaula sál forests in Kumaun the preceding cold weather. The beetles were egg-laying. For this purpose they tunnel down into the wood about $\frac{1}{4}$ in. to $\frac{1}{2}$ in., and then eat out a tunnel at right angles both to right and left of the entrance-tunnel. Small ridges and

unevennesses are left in this long tunnel, which is the egg-tunnel, and is carried round the stem parallel to the outer surface. In this tunnel a pair of beetles were usually found, apparently the ♂ and ♀. There is often a depression in the floor of the egg-tunnel just at its juncture with the entrance-tunnel, which may be the pairing chamber. The egg-tunnels are several inches in length. I have not taken the grubs.

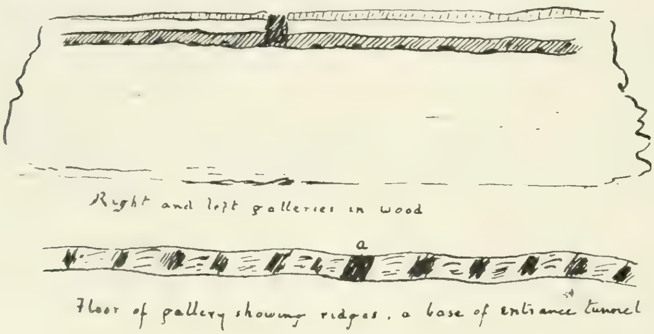


FIG. 96.
Galleries of *Heterobostrychus hamatipennis* in *Acacia catechu.* United Provinces Terai. (E. P. S.)

XYLOPERTHA.

Xylopertha ? sp.

REFERENCE.—Stebbing, *Ind. For.* xxviii, 287 (1902).

Habitat.—Seoni, Central Provinces.

Tree Attacked.—*Terminalia tomentosa.* Seoni.

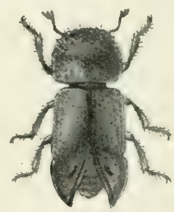


FIG. 97.
Xylopertha ? sp. × 5. Seoni.

Beetle.—Only an immature specimen of this insect has been obtained, superficially resembling a *Sinoxylon*, yellowish brown in colour, with ten-jointed antennae, the last three joints forming a terminal club, and joints three to seven being together longer than the first (eighth) of the club; the front tarsi covered on their inner surfaces with pubescence. Length, 8 mm.

Description.

A specimen of this insect was cut out of a post of *Terminalia tomentosa* badly infested by *Sinoxylon crassum*, at Seoni in the Central Provinces.

XYLODECTES.

Xylodectes ornatus, Lesne.

REFERENCES.—Lesne, *Ann. Soc. Ent. Belg.* p. 19 (1897); id. *Ann. Soc. Ent. Fr.* p. 538 (1901).

Habitat.—Kumaun, North India. Also reported from Kadegaon, Bombay; Madras; Nilgiris; Bhamo and Tharrawaddy, Burma; Tonkin; Sumatra; Borneo.

FIG. 98.
Xylodectes ornatus, Lesne
Kumaun, etc

Tree Attacked.—Khair (*Acacia catechu*). Submontane forests (Jaula Sál), Kumaun.

Beetle.—Elongate, parallel; reddish yellow; head, prothorax anteriorly, apical declivity, breast, and base of abdomen black or brown; elytra with lateral anterior margins brown; antennal club brown. Front of head granulous with a fine whitish-yellow pubescence; prothorax strongly constricted in front, rasp-like anteriorly. Elytra glabrous and brilliant dorsally and on sides; apical declivity circular, strongly punctate, with a fine light yellow or whitish pubescence; marginal teeth short, wide basally,

Description.

and pointed; the suture gaping on declivity, the apical margin elevate. Abdomen densely and finely punctate and pubescent. Last joint of anterior tarsus longer than any of the others. Length, 3.5 mm. to 6 mm.

In the ♂ the lateral marginal tooth of the apical declivity is inserted about the middle of the latter. In the ♀ this tooth takes off above the middle of the lateral margin of the apical declivity.

Life History.

Whilst engaged, in the middle of April, in examining some khair-trees felled during the preceding cold-weather months in the submontane sál forests near Jaula Sál, I discovered that a number of them were being tunnelled into by bostrychid beetles for ovipositing purposes. The trees had been felled for the preparation of cutch from the timber, and this latter was still green and sappy. The most abundant beetle present was the *Heterobostrychus hamatipennis* already dealt with. From short burrows in the wood, however, I cut two individuals of this *Xylodectes*. One of these insects was found dead at the end of its burrow, and it appeared to have been drowned there owing to the outflow of sap of the still green bast and wood into its burrow. The other was engaged in tunnelling down into the sapwood to oviposit. The tunnel, so far as it had been taken, went down for half an inch into the sapwood and then curved at an angle. It was unfinished.

The eggs of the first generation of the year are, then, laid in the early part of April in Kumaun. The number of life-cycles passed through in the year, if more than one, has yet to be ascertained.

Xylothrips.

Xylothrips flavipes, Illiger.

References.—Illiger, *Mag. für Insekt.* Heft 1-2, p. 171 (♂) (1801); *dominicanus*, Fabr. *Syst. Eleuth.* ii, p. 380 (♀) (1801); Lesne, *Bull. Soc. Ent. Fr.* p. clxxviii (1895); *sinuatus*, Stephens (*non* Fabricius), *Illustr. of Brit. Ent.* iii, p. 351, pl. xix, f. 6 (1830); Spry et Shuckard, *Brit. Col. del.* p. 44, pl. 53, f. 4 (1840); *religiosus*, Fairmaire, *Rev. et Mag. de Zool.* 2nd ser. ii, p. 50 (in part) (1850); *mutilatus*, Walker, *Ann. Mag. Nat. Hist.* 3rd ser. ii, p. 286 (1858); Waterhouse, ibid. 6th ser. i, p. 349 (1888); *iracundus*, Snell van Vollenhoven, *Rech. Faun. Madagas.* part 5, p. 10, pl. i, f. 7 (1869).

Habitat.—Peradiniya, Ceylon; Indo-Malayan, Madagascar, and neighbouring islands. In India it has been reported from Sylhet, Khasia Hills, Bhutan, Tetara (Bengal), and Travancore.

Tree Attacked.—Cocoa (*Theobroma cacao*). E. E. Green, from Peradiniya.

Fig. 99.
Xylothrips flavipes, Illiger.
Ceylon.

Description.

Beetle.—Chocolate-brown, posterior parts of elytra darker-coloured; often entirely reddish; under-surface lighter-coloured, especially the abdomen; antennae reddish, club brown. The rasp-like elevations on prothorax interrupted by small teeth; posterior surface shining or very finely punctured. Elytra finely punctate, stronger behind, especially near declivity; latter furnished with three marginal tubercles, the median one longest and most prominent; suture elevate on declivity, the sutural margin with one or several tubercles; suture slightly gaping. Breast and abdomen covered with a very fine and dense reddish-gold pubescence. Length, 6 mm. to 8.5 mm.

♂ Front of head transversely convex, finely and densely punctate, and finely pubescent, with a few scattered stiff hairs, more numerous near the eyes.

♀ Frontal crown circular or broadly V-shaped.

Life History. I have not taken this species in India. In July 1903 Mr. E. Ernest Green, Government Entomologist, Ceylon, forwarded some specimens to me at the Indian Museum, Calcutta, with the information that the insect tunnelled into the stems of cocoa-trees in Ceylon.

APATE.

Apate submedia, Walker.

REFERENCES.—Walker, *Ann. Nat. Hist.* 3rd ser. ii, p. 286 (1888) ; *jesuita*, Stebbing, *Depart. Notes*, i, p. 364 (1906).

Habitat.—Nellore, Madras.

Tree Attacked.—Casuarina (*Casuarina equisetifolia*). Nellore.

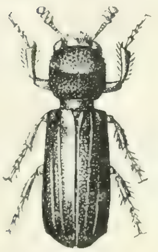


FIG. 100. *Apate submedia*, Walker. Madras.

Description. **Beetle.**—Black with parallel sides and a uniform breadth throughout of three-sixteenths of an inch, perhaps a little less anteriorly and a little more posteriorly. Body more than twice length of prothorax ; latter rounded and pitted above ; elytra with longitudinal ridges running down their dorsal surfaces with punctures between ; elytra deflexed at their apices. Abdomen red beneath. Legs black, short. Antennae with a club. Length, $\frac{11}{16}$ in.

Life History. This beetle is a wood-borer, and tunnels into the wood of the casuarina for egg-laying purposes. It was reported by the District Forest Officer as boring into trees in plantations at Nellore in June 1903, and therefore the eggs of one of the generations of the year are probably laid in that month. Nothing further appears to be known about its life history.

In all probability the beetle does not attack the tree until it is either felled or has from some cause become sickly. The damage done is to the timber ; in cases where the insect is numerous and the wood is required for planks or beams, the tunnelling of the beetle and its grubs, who also feed in the wood, would cause a considerable loss.

The length of time spent in the larval and pupal stages and the number of generations in the year have yet to be ascertained.

SINOXYLON.

Sinoxylon crassum, Lesne.

REFERENCES.—Lesne, *Ann. Soc. Ent. Belg.* xli, p. 21 (1897) ; Stebbing, *Depart. Notes*, i, p. 12 (1902) ; *Ind. Mus. Notes*, v, p. 106 (1903).

Habitat.—Dehra Dun, Siwaliks, Submontane forests, Kumaun ; Changa Manga, Punjab ; Raipur and Mandla, Central Provinces ; Goalpara, Assam ; Tenasserim. Also reported from Belgaum (Andrewes), Kanara (T. R. D. Bell), Burma (G. Q. Corbett).

Trees Attacked.—Khair (*Acacia catechu*): Raipur, Central Provinces (F. Gleadow); *Terminalia tomentosa:* Seoni, Central Provinces (Hanson and Stebbing); Sál (*Shorea robusta*): Dehra Dun (Littlewood and Stebbing); Kandrahi, Mandla (*mihi*); *Anogeissus latifolia:* Horai, Kumaun (*mihi*); Sissu (*Dalbergia sissoo*): Changa Manga Plantation (Coventry and Stebbing); Dehra Dun, and Goalpara, Assam (*mihi*); Phulahi (*Acacia modesta*): Changa Manga (*mihi*); *Pterocarpus marsupium:* Kisli, Banjar Valley, Mandla (*mihi*); Harra (*Terminalia chebula*): Kandrahi, Mandla (*mihi*); *Albizzia procera:* Ataran River, Tenasserim (*mihi*); *Prosopis spicigera:* Sukkur, Sind.

FIG. 101. *Sinoxylon crassum*, Lesne. × 4. India (except Madras), Burma.

Beetle.—Elongate, oblong, stout, slightly dilated posteriorly, very dark brown, almost black, rather shining; antennae and legs reddish-brown. Head vertical, hidden beneath prothorax, punctate, with prominent light-coloured eyes. Prothorax very convex, rounded in front, incurved behind; the anterior portion is coarsely and densely tuberculate and rasp-like, strongest on margin and decreasing in size towards centre of disk; three prominent teeth on each side on the anterior margin; posterior half rugose. Elytra parallel, convex, striate-punctate, the apex truncate and depressed, the striae most prominent apically, where they project in two elongate median sutural teeth, with two short stout teeth laterally on each side; declivity rugose-punctate. Length, 7 mm. to 8½ mm.

Description.

Life History.

Since I first described a part of the life history of this insect in *Departmental Notes* in 1902, a great deal of additional information has been collected on the subject. My first study of its habits was made in the Changa Manga Plantation, where the insect infests the sissu (*Dalbergia sissoo*) to a serious extent, in company with *Sinoxylon anale*. Mr. B. O. Coventry had reported in 1899 that bostrychid beetles attacked sissu billets in the Changa Manga Plantation; but the identity of the insects remained unknown until April 1901.

The appearance on the wing of the first generation of the beetles of the year varies in different parts of the country. In the north of India the beetles commence egg-laying in wood in April. They are also to be found thus engaged during this month in the Central Provinces, though it is not unlikely that these beetles may be those of the second generation. I took a generation of the beetles just maturing towards the end of May in Goalpara, Assam, these being probably the second generation of the year. At Pyimnaseik, on the Ataran River in Tenasserim, I found a generation maturing and leaving the wood on 19 March, probably the beetles of the first generation of the year issuing to lay the eggs of a second generation.

The eggs are laid by the beetles in the wood of a variety of trees, and are most usually laid in felled timber which has not become too dry. Occasionally, when plentiful, they will tunnel into sickly or dying standing green

FIG. 102. Entrance holes and tunnels of *Sinoxylon crassum*, Lesne, in bark and wood of a *Pterocarpus marsupium* pole. Mandla, Central Provinces.

trees. On several occasions I have found them engaged in this manner. They undoubtedly prefer, however, timber which has been felled for a short period, the length of time depending upon whether the material has been cut in the cold-weather months, when it loses its sap slowly, or in the hot weather. The beetle will not usually infest absolutely dry timber, and in this respect differs from its oft-time companion, *Sinoxylon anale*, which is described below.

To oviposit the female tunnels into the wood either through the bark or in at one end of a cut log or billet, the presence or absence of the bark on the wood apparently being immaterial. This tunnel is a short one, is taken at a varying angle to the exterior surface of the log, and is generally about a quarter to half an inch in length. Its end is enlarged into a chamber, so that two beetles can move about in the space, and a male beetle enters to the female here and fertilizes her. A tunnel is then carried to the heart of the tree (or at least into the heartwood in big trees), whose direction changes several times. In some cases the beetle starts by taking

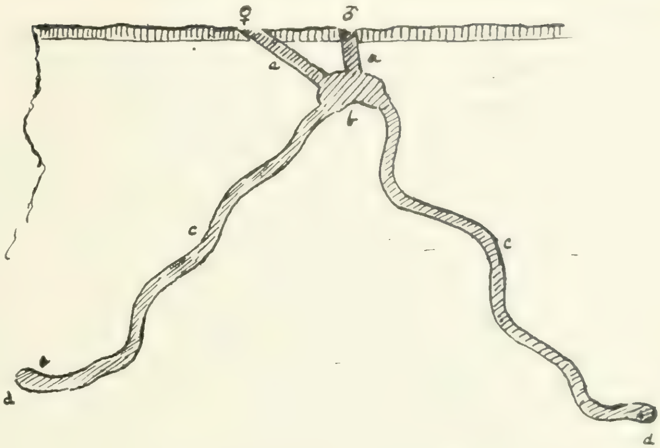


FIG. 103.—Galleries of *Sinoxylon crassum* in the wood of *Pterocarpus marsupium*. *a a*, ♂ and ♀ entrance-tunnels; *b*, pairing-chamber; *c c*, egg-tunnels; *d d*, position of eggs. Mandla, Central Provinces. (E. P. S.)

the tunnel at right angles to its former direction, eating out the gallery just below the external surface of the sapwood, and leaving but a thin lamella of wood between it and the outer air, the gallery running round the circumference of the tree for a varying distance. The direction is then changed, and the tunnel, with one or more curves in it, is carried into the heart-wood of the tree. The male is at times found in this egg-tunnel, and I think it is probable that he pairs with the female more than a single time. Also he fertilizes more than one beetle, as I have found cases where more than one tunnel takes off from the pairing-chamber, and yet there was but one entrance-hole on the outside, although there was a female beetle in each egg-tunnel engaged in hollowing the latter out. These egg-tunnels vary in length, being occasionally several inches, and when bored in the harder heart-wood they are often found to run horizontally round the softer part of a "ring" of the wood, as shown in the diagram of a section of *Terminalia chebula*. The end of the tunnel is usually parallel to the long axis of the tree. The eggs are laid at or near the bottom in masses of powdered wood-dust. This egg-gallery takes from four to eight days to construct, the eggs hatching out within forty-eight hours or so. The operations of the beetle in the tree or log are usually easily seen by the heaps of sawdust which are pushed out from the tunnel through the entrance-hole and project in small cylinders or cover the bark with sawdust.

FIG. 104.—Cross section of a log of *Terminalia chebula*, showing (*a*) entrance and (*c*) egg tunnel of *Sinoxylon crassum*. Mandla, Central Provinces. (E. P. S.)

The larvae feed entirely on the wood, eating out tunnels in the long axis in an irregular manner, which coalesce and reduce the wood substance to powder. In the case of old large trees these tunnels are

mostly confined to the sapwood, the egg-tunnel being only carried into the outer heart-wood. When poles are attacked, however, the whole structure of the wood is reduced to powder. On becoming full-fed, in four to six weeks (or in the colder parts of the country in eight to ten weeks), the grubs pupate in a slightly enlarged chamber at the end of their galleries. This chamber is free of wood-dust, the rest of the larval gallery being blocked with it. About two to three weeks are passed in the pupal stage. On maturing the new beetles bore or force their way through the mass of powdery material to which the wood has been reduced until they find a female egg-tunnel, up which they crawl, and so leave the tree. If they are unable to find a ready-made exit they tunnel out of the tree for themselves, but the vast majority leave by an old entrance-hole made by the parent generation, and it is for this reason that badly infested poles and trees do not show on the outside the serious nature of the attack to anything like the same extent as is the case with the Scolytidae, as both entrance-holes and exit-holes are far fewer in number.

Another reason, I have noticed, is that when, as is often the case, *S. anale* is accompanying *S. crassum* in its attack, the former and smaller beetle often makes use of the entrance-holes of its larger companion to enter the tree by. Whether this habit is merely laziness on the part of the beetle, or whether it exhibits a certain amount of wide-awakeness, I am unable to say; but, of course, one of the most dangerous periods of the beetles' lives is that during which they are commencing their tunnel into the wood, and before they have got down flush with the outer surface, for during this time they are exposed to the attacks of their many numerous enemies, both animal and insect.

A very important and as yet unrecorded feature of the life history of this beetle has rendered it a pest of the first importance, and will probably, in conjunction with the damage done by other insects whose life histories are at present unknown, be found to account for that destruction of young sál growth in the forest for which up to date no cause has been assignable. Whilst the students of the Imperial Forest School were in camp at Phandowalla in the Dun in February 1902, Mr. A. M. Littlewood (now of the Madras Forest Department) forwarded me some small sál shoots and twigs from the sál coppice areas which had been tunnelled into and hollowed out by beetles. I examined a number of these shoots, and subsequently obtained others out in the forests of the Dun and in Garhwal and Kumaun myself. The shoots sent me by Mr. Littlewood contained living *S. crassum* beetles. The insects had evidently tunnelled into the shoot the previous autumn, the large round entrance-hole being very discernible on the external surface of the shoot, and then hollowed it out, proceeding upwards. Much of the interior of the shoot appeared to have been eaten. The beetle, with the approach of winter, hibernates in the hollowed-out shoot. Instances of this nature, by which an insect commits damage in two distinct forms, are known amongst the Scolytidae, as, e.g., the European *Hylurgus* (*Myelophilus*) *piniperda*, L., of

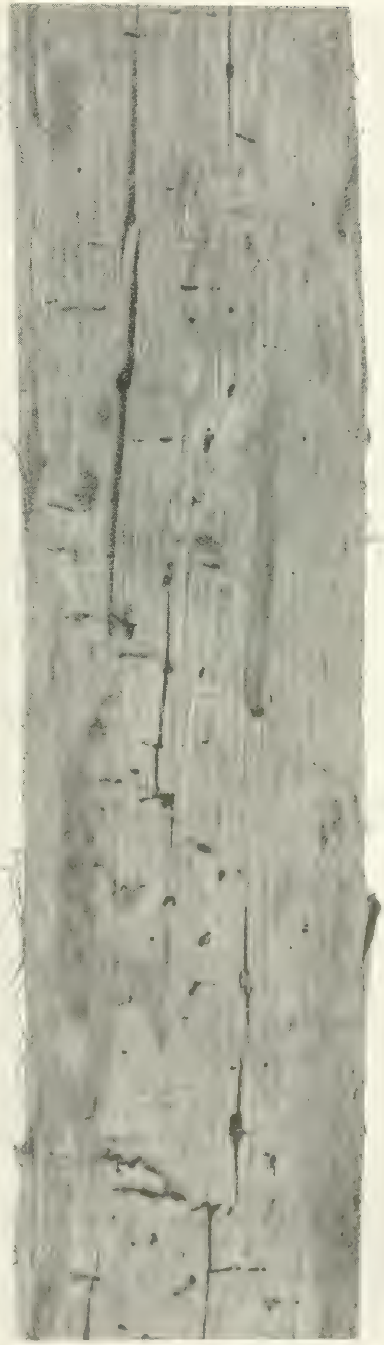


FIG. 105.—Entrance holes and tunnels of *Sinoxylon crassum* in sál wood. Mandla, Central Provinces.

the Scots pine; but in the latter case the insect is not a wood-borer in any stage of its existence. I shall show later that the sál scolytid *Sphaerotrypes siwalikensis* of the Siwalik sál areas also tunnels into green sál shoots to feed, as does the Assam species; but I have found no recorded instance of a bostrychid acting in this manner. It was in February 1902 that Mr. Littlewood made this discovery, and between 1905 and 1909 I was able on several occasions to corroborate it. To leave no opening for doubt as to the identity of the species both Mr. Littlewood's and my own specimens were kindly identified for me by M. Lesne.

As I have above indicated, the length of time taken by each generation or life-cycle of the beetles to mature, and the number of such, necessarily vary with the part of the country the insect is inhabiting. They will be more numerous in the damp tropical heat of Tenasserim than in Changa Manga in the Punjab. The number is probably from

three in the north to five in the south of Burma, three to four in the Central Provinces, four to five in Assam.

I have not taken *S. crassum* in Madras. There seems no reason to suppose it is not to be found in the Presidency, since it is known in Burma. The common species of the genus there are, however, *S. indicum* and *S. conigerum*, both of which are dealt with later on.

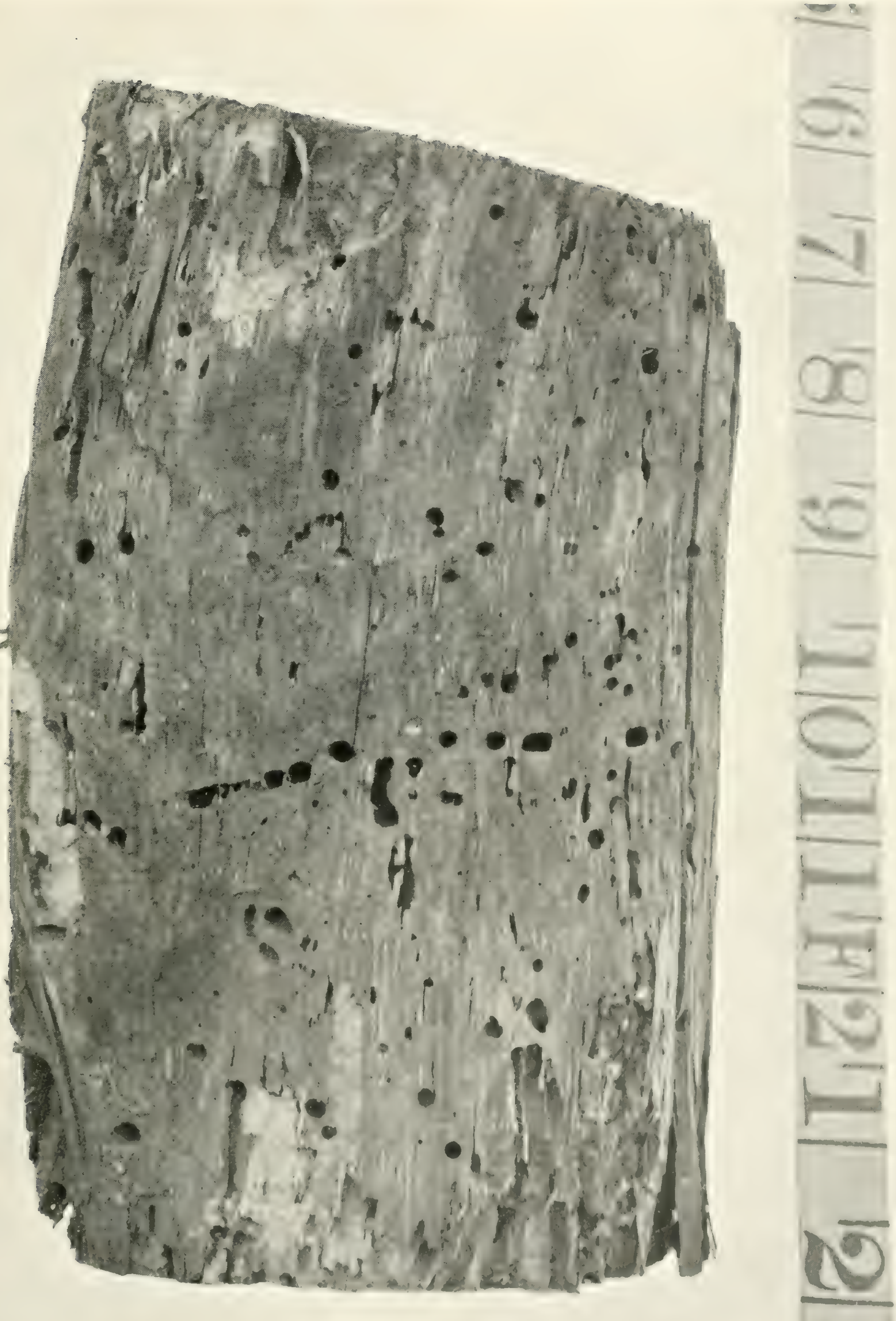
Relations to the Forest.

The life history of this insect shows it to be a pest of a serious nature both in the forest and in the wood depot. In the forest its habit of tunnelling into the young shoots or leading shoots of sál saplings in coppice areas and elsewhere makes it a pest of the first magnitude, for it must be remembered that the insect attacks the wood of a variety of trees, and study may show that the beetle similarly feeds in and tunnels into the shoots of one or more of these trees. This phase of its life history requires further careful investigation.

The beetle is a destructive pest as a wood-borer, not only by its direct action in riddling the timber, and thus rendering it useless save for firewood and greatly reducing the value of billets even for this purpose, but also by its indirect action, in that the large amounts of sawdust thrown out of the borings by the beetles often give good sound logs lying in the forest or depot the appearance of being more seriously riddled, and consequently ruined, than is the case in reality. The depth to which the beetle carries her egg-tunnel varies with the hardness of the heart-wood of the tree, only the sapwood being affected in the case of sissu (fig. 27). In the case of species such as *Pterocarpus marsupium* and *Albizzia procera* the beetle goes deep into the interior of poles.

In the Changa Manga Plantation the beetle exists in considerable numbers, and has in the past done serious damage to the fresh-cut billets and logs of sissu (*D. sissoo*) both here and in the Shahdera Plantation nearer Lahore. I have also found it in numbers in stag-headed and sickly standing green trees. It infests *Acacia modesta* wood in the plantation in a similar manner. In the case of the felled material stacked in the Changa Manga Fuel Depot (the plantation chiefly supplies fuel for Lahore), the beetles have in the past so riddled the whole of the sapwood of the stacked billets as greatly to lower their value, or even reduced them to such a condition that their sale could not be effected. Stacks of billets so treated are covered on the outside with a yellowish wood-powder pushed out of the tunnels of the excavating beetles, and the wood has a dilapidated decaying appearance which militates against a chance of its sale, whilst at the same time its weight is greatly reduced, and with this its commercial value (cf. fig. 27).

At Changa Manga *S. crassum* commences laying the first eggs of the year in April, the beetles usually being plentiful in the plantations. In the middle of May but few are to be seen, but the wood-stacks are full of larvae and pupae. A second lot of eggs are laid in June–July, giving rise to



Entrance and exit holes of *Sinoxylon crassum*, Lesne, and *Lyctus spinifrons*, Lesne, in *Terminalia tomentosa*. The white patches show where the wood has been reduced to powder by the boring operations of the larvae. Seoni, Central Provinces.

beetles which appear in September and October. This is the life history of the insect in Dehra Dun and throughout the Siwaliks and submontane parts of Garhwal and Kumaun. Here the insect attacks the sál, both the timber and the green twigs and tops of green saplings, as already described; I have also found it infesting *Anogeissus latifolia* poles in the Horai Forest in Kumaun.

In the Central Provinces, Mr. F. Gleadow procured khair (*Acacia catechu*) poles from Raipur in July 1890 which were badly infested by this beetle.

I first took this beetle in the Singbhum forests of Chota Nagpur from sál beams in newly constructed forest resthouses in April 1897. In August 1901, whilst in Seoni in the Central Provinces in company with Mr. C. O. Hanson, Deputy Conservator of Forests, I noticed the borings of bostrychids in *Terminalia tomentosa* posts in newly constructed bungalows.* The following is a brief extract from my report on the subject:—

"The wood of this tree is used to a considerable extent for construction work in the Central Provinces. At my request Mr. Hanson forwarded an infested rafter to me at Dehra Dun in the following September. It was found to be infested by *Sinoxylon crassum*, an unknown species of *Xylopertha* already alluded to, a new species of *Lyctus*" (recently described by Mr. P. Lesne as *Lyctus spinifrons*), "and various predaceous and parasitic insects. The *Sinoxylon* was very numerous, and was evidently the generation of beetles issuing in September from the eggs laid by the July generation found by Mr. Gleadow."

I found the beetle pairing and egg-laying in Mandla in the Central Provinces between the end of the first and the last week of April 1909. The beetle was infesting various species of trees, most of which had been cut down from one to three months before on a new road alignment through the forests. A felled *Pterocarpus marsupium* pole (fig. 102) examined contained a number of beetles whose operations extended right through the pole, some of the egg-tunnels traversing it from one side to near the outer surface of the sapwood on the other. The wood was still fresh and sappy, the tree having been cut into a couple of logs which were lying unbarked. In several of the tunnels I found a male and female beetle. In some cases here I noted that occasionally the entrance-holes of the sexes were separate, those of the males being smaller than the females, the separate tunnels both connecting with a large chamber eaten out from a quarter to half an inch down in the sapwood as shown in fig. 103, which is the pairing-chamber. The beetles so engaged were laying the eggs of the second generation of the year.

From the same forests in Mandla I took the insect in felled sal-trees, but only sparingly. At Kandrahi in Mandla I found numbers of the beetles in a large *Terminalia chebula* log which had likewise been cut in the preceding February on the road alignment. These beetles had just matured and were issuing to pair and oviposit, a number having already left the log. I took the insects on 26 April, thus showing that the first generation of the year in

* *Vide* my note on "Insect Life in a *Terminalia* post," *Ind. Forester*, vol. xxviii, p. 287 (August 1902).

Mandla takes some two to two and a half months, from February to near the end of April, for the tree in question was a green healthy one before being felled in February, and showed no signs of previous insect attacks. In this tree I was able to see a good example of the way the beetle curves its egg-tunnel concentrically round the rings of the wood. I show a diagram of this in fig. 104 from a drawing made on the spot.

These three sets of observations prove that *S. crassum* has at least three broods in the year in the Central Provinces, the first between February and April, the second from April to July, the third from July to September. It is possible that the beetles of a fourth may issue early in November and tunnel into the shoots and twigs of trees to hibernate, or the September generation may act in this manner.

Towards the end of May 1906 I took the beetle in *Dalbergia sissoo* on the Sunkos River in Assam. There is a considerable amount of more or less scattered sissu growth along the banks of this part of the Sunkos. I examined this to ascertain whether the leaf-rolling *Apoderus* weevils (p. 416) were at work here. I did not find them, but I found a blown-down tree full of the bostrychids *S. crassum* and *S. anale*. In this attack I noted particularly the way the beetles sometimes carry a portion of their egg-tunnels, curving round the circumference of the tree, leaving merely the thinnest of lamellae of outer sapwood (in places where the bark had fallen off) as a protection to the gallery, rather after the fashion in which termites work. This generation of beetles taken on 26 May 1906 was just maturing, and the bulk of the beetles would evidently issue early in June—probably those of the second generation of the year, who would lay the eggs of a third generation in June.

I was down in Tenasserim in March 1905, and in the latter part of the month I went for a trip up the Ataran River by launch. We burnt fuel on the launch, and an examination of this material showed it to be badly infested by bostrychid beetles. One small log of *Albizzia procera* was almost entirely riddled by *S. crassum* beetles, and scarcely scaled one-sixth of its proper weight owing to the amount of wood which had been eaten out by the beetles and their grubs. The whole of the interior was a network of tunnels. The generation was just maturing, many of the beetles having already left the tree. Numbers of others were engaged in eating out their flight-holes. My attention was drawn to this, as the outer surface of the log contained a number of holes much too small for *S. crassum* to leave by. I thought another smaller bostrychid was present, but an examination showed these holes to be the partially eaten exit-holes of the beetle. This was interesting, as it proved that the third week in March is the time of appearance of what is probably the first generation of the beetles issuing to lay the eggs of the second, and secondly that the greater part of a flight of this species mature and leave the tree together, and that there is consequently not so great an overlapping of generations as obtains amongst the Scolytidae. This I have noticed on other occasions.

In December 1908 I received a consignment of beetles from Sukkur, Sind, which were reported as seriously infesting and reducing the value of *Prosopis spicigera* billets. This wood is or was cut in considerable quantities and sent up to Quetta as fuel. In the latter place anxiety had been aroused at the thought that this insect might be identical with the Quetta borer beetle (*Æolesthes*, see p. 307), and that the borer which was doing such damage in the station was being imported with the firewood from Sind. Investigation speedily set this alarm at rest. The beetles in the fuel were *Sinoxylon crassum* and *S. anale*. I saw no evidence of the attacks of these beetles in Quetta, and it is probable that the beetles issuing there from the firewood are killed off by the cold.

Protection and Remedial Measures.

Owing to the curious nature of the life history of this pest, methods of protection against it must of necessity partake of a two-fold character.

When the beetles are present in fuel areas in the numbers I observed at Changa Manga in the Punjab in the years 1901 and 1905, operations mentioned below should be put into force to reduce its numbers.

In the Punjab and generally in the north of India the insect's active life lasts from April to late October or early November, after which period it hibernates either as a beetle or larva. In Changa Manga it was found that both the spring and summer generations of the beetle attacked the felled and stacked sissu wood which had been cut during the previous cold weather, November to March. This wood is collected and placed in stacks on the compartment lines in the forest, and was allowed to remain there till the following October in order to render it lighter by loss of moisture. This coincided exactly with the requirements of the *Sinoxylon* and its companion *S. anale*, who both attacked the material thus stacked on the compartment lines in large numbers. The beetle was equally plentiful at the fuel depot a few miles from the plantations. My recommendations in 1901 were as follows:—

1. Remove from the forest as soon as felled the amount of wood annually cut in the compartments, no fresh-cut wood being allowed to lie in the forest after the end of March.

2. Let the fellings be so arranged that wood is not cut in advance of the selling power, and thus allowed to lie for an uncertain period in the fuel depot. The amount on hand at any one time being thus smaller, the number of breeding places for the insects will diminish.

3. The number of breeding places being thus reduced, measures will have to be put into force to deal with the large numbers of beetles which under these circumstances will attack the green standing trees.

(*a*) Careful watch to be kept for attacked standing trees. They will be recognized by small "shot holes" appearing in the bark, probably with particles of sawdust at or near their entrances. Such

trees, if badly infested, should be cut down at about the end of May (when they will contain larvae and pupae) and be chopped up and burnt. To ascertain the time to fell the tree, cut out a strip of bark and see if the sapwood contains small white grubs or pupae. If so, this is the time to remove the tree. If it is left longer the larvae and pupae will change into beetles, and these will then bore their way out and leave the tree and attack fresh ones. This careful watch should be kept up between April and October for a year or two after the plan of immediately removing from the forest the cut fuel and logs has been adopted.

(*b*) To save green sickly trees from being promiscuously attacked, "trap" trees should be used. Suitable trees are selected in convenient places adjacent to the areas in which fellings have just been made, and are ringed or felled about February. The April beetles will lay their eggs in these trees in preference to attacking green ones. The trees should be felled in May, cut up, and burnt. In June another set of trees should be similarly prepared to catch the second generation of beetles, this second lot being cut down and burnt about the end of August.

Careful watching will show whether it is necessary to repeat this treatment the next year.

During my visit to Changa Manga in May 1905 I found that these recommendations had been given effect to in some measure. The removal of the wood was commenced soon after the felling ceased in March, the whole of it being carried to the depot in from two to three months. The old unsold wood in the depot was auctioned off annually.

These suggestions which were drawn up for Changa Manga apply equally to other parts of the country, the only difference being that the beetles appear earlier in the year and remain later, their ovipositing months consequently being to some extent different from those of the north of India.

Where possible, fresh-cut poles should be kept under water whilst the chemical changes in them during the process of drying are taking place. Or, where such treatment will not injure their utilization, they should be soaked in crude Rangoon oil as already described for bamboos on p. 136.

So long as *S. crassum* was known simply as a wood-borer the damage done by it was looked upon as affecting only the commercial value of the tree. The discovery that it tunnels into the young green shoots of sál (and possibly other) trees and the tops of saplings alters the position of the insect as a pest. It becomes obvious that a first necessity is cleanliness, and that in so far as is possible all felled material must be removed from the forest. In sál coppice areas this should be laid down as a rule from which no deviation is permissible, all the refuse from "tops" etc. of fellings being burnt. If an area is seen to have the leaders of saplings and twigs badly attacked by the

insect a careful collection should be made of the infested parts, which should be burnt.

Parasitic and Predaceous Foes.

A number of the parasitic and predaceous foes of this *Sinoxylon* and its companion *S. anale* have been discovered, and something of their life histories worked out. Histeridae, Trogositidae, and Colydiidae are most commonly found as companions and predators of these borers.

Bracon sp.—In a billet of sissu wood badly infested by *S. crassum* at Changa Manga I found two Bracon cocoons in the pupating-chambers of the *Sinoxylon* grubs, as shown in fig. 106. This was on 20 May. The cocoons are papery in structure, elongate, with truncate ends. One was

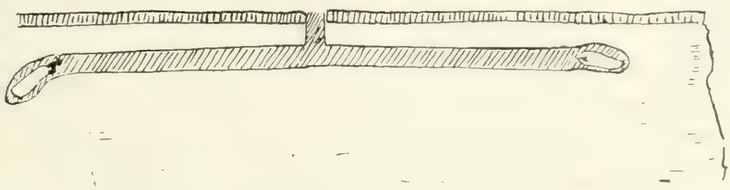


FIG. 106.—Cocoons of *Bracon* sp. in the tunnels of *Sinoxylon crassum* in sissu wood. (The drawing is diagrammatic, the tunnels being shortened.) Changa Manga. (E. P. S.)

empty, the fly having flown. The other had a hole eaten at one end, through which protruded the head and thorax of a small, delicate yellowish Ichneumon fly. This fly appeared to be in the act of leaving the pupal case, to crawl up the tunnels of the grub and beetle to escape from the tree. It had, however, died from some cause or other.

The determination of this parasitic fly has not proved possible. Its grub is undoubtedly parasitic on the *Sinoxylon* larva.

Bracon sp.—Some mature flies of a species of Bracon at present undescribed were obtained from a *Terminalia tomentosa* post from Seoni, in the Central Provinces, which was badly infested by *S. crassum*.

Fly.—The mature fly is yellowish brown in colour, with long, slender antennae, the characteristic wing-venation of the Bracon flies, and is 2.5 mm. in length.

FIG. 107. *Bracon* sp. × 6. Seoni.

These flies were found issuing from the log by the holes of the *S. crassum* beetle, and matured at the same time as the beetle. It is probable that their grubs feed parasitically on the *S. crassum* grubs.

Amongst the predaceous insects which attack *Sinoxylon crassum*, several species of the family Histeridae are known to prey upon the beetle-borer.

Teretriosoma Stebbingi, Lewis (p. 104).—This and two other species of the genus are commonly found in the tunnels of this *Sinoxylon*, and are known to prey upon the grubs of the beetle.

FIG. 108. *Teretriosoma Stebbingi*, Lewis. Changa Manga.

The beetle is a small, compact, cylindrical, somewhat elongate insect, pitchy-brown in colour, shining and rather densely punctured above. The head is not hidden by the prothorax; antennae are short and bent, with a compact club. The elytra are closely applied to the body, but leave the last two segments exposed. Five ventral segments of the abdomen are visible. Length, $2\frac{2}{3}$ mm.

Teretriosoma cristatum, Lewis (p. 104).—This beetle is very similar * to the one above described. It is piceous in colour, the thorax being more convex than the dorsal region, and the scape of the antennae bearing long, palish hairs.

Teretriosoma intrusum, Marseul (p. 104).—The characters of this beetle are very similar to those of the above-mentioned two species, and for the purpose of the forester the insect will be sufficiently recognized from the above descriptions and figure.

I have taken these *Teretriosoma* very commonly in Changa Manga, in the sissu billets tunnelled by the *Sinoxylon* beetles, and the last two at least in the Central Provinces (Seoni, Mandla, and elsewhere). I have also had *T. intrusum* sent to me with *S. crassum* and *S. anale* from Sukkur in Sind, where they had been taken from the tunnels of the beetle in *Prosopis spicigera*.

I have taken the larvae of these *Teretriosoma* in the tunnels of the *Sinoxylon* beetles, but have not yet proved that they are predaceous upon the borer-beetle larvae.

Teretrius indus, Lewis (p. 105).—This is a small histerid, in shape, appearance, and characters not unlike the above-described beetles. I took specimens from a *Terminalia tomentosa* post obtained in Seoni. The species proved new to science, and was described by Lewis.

FIG. 108A. *Teretrius indus*, Lewis. Seoni.

Teretrius mogul, Lewis (p. 105).—In *Ann. Nat. Hist.* ser. 8, viii, p. 78 (1911), Lewis describes this species as follows:—"Cylindrical, robust, black and shining, antennae and legs piceous. Wholly punctured above, very similarly to *Kraatzi*, which Marseul calls 'sat fortiter et dense punctatus.' The marginal stria of the thorax is complete behind the head; the prosternum, the striae gradually diverge from the base to the apex, sometimes terminating at the suture, sometimes joining the marginal stria along the anterior rim (in one example this variation occurs on one side and not on the other); the mesosternum is prominently produced, but the marginal stria, beginning at the coxae, does not follow its contour, but is arched and fine, and leaves rather a wide anterior margin; all the sterna and the first abdominal segment are finely and sparingly punctulate. The anterior tibiae are 10–12 denticulate, intermediate 7–8, posterior 4–5 spinose. Length, $3\frac{1}{4}$ to $3\frac{1}{2}$ mm. The peculiar mesosternal stria is a remarkable character which distinguishes it from all the other species I know."

* *Vide* footnote on p. 104. This species is the female of *T. Stebbingi*.

I took specimens of this *Teretrius* in the tunnels of *S. crassum* and *S. anale* in sissu-trees at the Changa Manga Plantation in May 1905. The histerids were in company with *T. intrusum* and *T. Stebbingi*, and are predaceous upon the *Sinoxylon* beetles.

Other beetle predators upon *S. crassum* and *S. anale* are species of the genus *Bothrideres* (family Colydiidae), the genera *Alindria*, *Melambia*, and *Tenebroides* (family Trogositidae), and *Hectarthrum* (family Cucujidae).

Bothrideres andrewesi (p. 112).—The beetle is narrow, elongate, parallel, shining, and light brown in colour above and below. The head is rather large, and protrudes beyond the prothorax; eyes round and fairly prominent; antennae end in a terminal club. Prothorax a little separated from elytra, squarish; head and prothorax strongly punctate above. Elytra deeply ridged longitudinally, and punctate between the striae. Legs light brown; tarsi four-jointed, none of joints being broad; hind coxae are separated, fore and middle ones close to one another; five visible ventral segments. Slender, active insects; very quick in their movements.

× 5

FIG. 109. *Bothrideres andrewesi*, Grouv. Changa Manga.

Life History.—This beetle, which is predaceous, has been taken in sissu wood at Changa Manga, in the galleries of *S. crassum* and *S. anale*, in a manner similar to that in which the *Teretriosoma* beetles above described were found, and was more especially abundant in the galleries containing numerous *S. anale* larvae; it is not improbable that its attacks are confined to these latter, and perhaps to their pupae.

Alindria orientalis, var. **parallela**, Lev. (p. 114).—An elongate, parallel, black beetle, with the thorax smooth and shining, uniformly punctate, truncate in front, and sinuate, constricted behind. Elytra broader than thorax at its basal part, apices rounded, the suture gaping, prominently striate-punctate. Length, 13 mm. to 14 mm.

Alindria orientalis, Redtenb. (p. 114).—Larger than last, rather broader. The elytral striae broader, more prominent, and punctate. Legs stout; front tibiae toothed on outer edge. Length, 14.5 mm. to 15.5 mm.

Larvae.—Two forms of larvae have been taken: (*a*) White, with black head and thorax, two black spots placed transversely on second and third thoracic segments, and a black patch on abdominal segment dorsally; three pairs of thoracic legs; length, 1⅛ in. (*b*) Head black, first two thoracic segments white, rest white with a dark-coloured roundish patch on third–eleventh segments; length, 1¼ in.

FIG. 110. *Alindria orientalis*, var. *parallela*, Lev. Changa Manga.

Life Histories.—These two beetles are the commonest of the predaceous foes of *Sinoxylon crassum* and *S. anale* at Changa Manga in the Punjab. In May 1905 the beetles were taken literally in hundreds in the tunnels of the wood-borers in some large dying sissu-trees. Some of these trees were badly

infested by the bracket-like fungus *Polystictus* (*Polyporus*) *egregius*, Massee, and owed their sickly condition to this fact. The *Sinoxylon* beetles had attacked them near the foot of the trunk, and had penetrated down into the base of the root a foot or two below the surface of the soil. The *Alindria* beetles taken were mostly mature, whilst the bulk of the *Sinoxylon* were in the pupa or immature-beetle stage, with a few mature beetles. A few *Alindria* larvae were taken, and these feed predaceously upon the *Sinoxylon* grubs. I have not ascertained whether the *Alindria* beetles feed upon the mature *Sinoxylon* ones, but they attack the immature beetles.

FIG. 111
Melambia sp. prox. *memnonia*, Pascoe. Changa Manga.

Melambia sp. prox. **memnonia,** Pascoe (p. 115).—The *Melambia* beetles are of stouter build than the *Alindria*, and easily distinguished by the anterior outer angles of the prothorax, which is broader than long, being produced forward, the anterior margin being sunk between them; the elytra are broader behind, thickset, bluntly rounded at apex, the suture not gaping at apex; the three terminal joints of antennae are prominent, as in cockchafer beetles. In the species here dealt with, the sides of the thorax are straight, slightly constricted in posterior half, the posterior marginal prolongations prominent, uniformly punctate, punctures large; elytra punctate-striate, punctures fine. Length, 14.5 mm. to 16 mm.

This insect was found preying upon the *Sinoxylon* beetles in tunnels in dying sissu-trees at Changa Manga, in company with the *Alindria* beetles described above. It was not found to be numerous.

Melambia crenicollis, Gnév. (p. 114).—Resembles the last in general shape, but differs in having the sides of the prothorax rounded, the anterior marginal prolongations being smaller and the elytra much more strongly punctate-striate than in *M.* sp. prox. *memnonia*. Length, 12.5 mm. to 13.5 mm.

I have taken this beetle in the mature state in sál-trees in the Siwaliks, (Dholkhand) towards the end of January 1901 and 1902, and in *Terminalia chebula*, in Mandla, in April 1909.

Tenebroides (**Trogositita**) **rhizophragoides,** Walker (p. 115).—The beetle is long, rather narrow, flat, with a prominent head and mandibles, and a squarish prothorax. Elytra finely striate-punctate, dark brown in colour. Length, 8 mm.

Specimens of this beetle were bred out of a log of *Terminalia tomentosa* badly infested by *Sinoxylon crassum* beetles. Observations showed that both the grubs and mature beetles are predaceous upon the *Sinoxylon* insects.

Hectarthrum heros, Fabr. (p. 116).—The beetle is black, shining, with long, prominent, thickly jointed antennae and prominent mandibles. The prothorax is elongate, smooth, with a longitudinal impressed line laterally. The elytra smooth, rounded at apex, with several longitudinal channels down them. Length, 12 mm. The heavy, knobbed antennae, prominent head and mandibles, and the smooth, shining, black appearance of the insect, render it easily recognizable.

FIG. 112.
Hectarthrum heros, Fabr.
India and Burma.

Life History.—*Hectarthrum heros* is a common beetle in the forest throughout many parts of India. It is at times to be found swarming beneath the bark of trees, and is evidently predaceous upon a variety of species of insects.

In company with the *Trogositita* beetle above alluded to, I bred it out, in September 1901, from *Terminalia tomentosa* logs from Seoni, in the Central Provinces, which were badly infested by *S. crassum*, the beetle being evidently predaceous upon the *Sinoxylon*. Towards the end of April 1909, again, I obtained the insect from a *Terminalia chebula* tree felled a short time before, which was being tunnelled into by the *Sinoxylon*. In this latter case the *Hectarthrum* beetles were ovipositing in the tunnels of the *Sinoxylon* beetles, eggs quite unlike those of the bostrychid being obtained.

Sinoxylon anale, Lesne.

REFERENCES.—Lesne, *Ann. Soc. Ent. Belg.* xli, p. 21 (1897); *Sinoxylon* sp. *Ind. Mus. Notes*, iii, 125 (1894); Stebbing, *Depart. Notes*, i, 16 (1902).

Habitat.—Punjab, United Provinces, Central Provinces, Bombay, Bengal: Upper and Lower Burma.

Trees Attacked.—*Terminalia belerica:* Thana, Bombay (F. Gleadow): Sál (*Shorea robusta*): Singbhum, Chota Nagpur; Mandla, Central Provinces, and Dehra Dun (*mihi*); Sissu (*Dalbergia sissoo*): Changa Manga, Punjab (B. O. Coventry *et mihi*): Phulahi (*Acacia modesta*): Changa Manga (*mihi*): *Xylia dolabriformis* and Shisham (*Dalbergia latifolia*): Kanara (T. R. Bell): *Prosopis spicigera:* Sukkur, Sind; *Terminalia tomentosa:* Seoni (C. O. Hanson *et mihi*); Khair (*Acacia catechu*): submontane forests, Kumaun (*mihi*); Bamboo (*Dendrocalamus strictus*?): Mohnyin, Katha (*mihi*): *Pterocarpus marsupium:* Kahna, Mandla (*mihi*); "Jungle Woods" spp. ?: Ataran River, Tenasserim (*mihi*); Bamboo (sp. ?): Salween River, Tenasserim (*mihi*).

Beetle.—Resembles *S. crassum* in appearance, but is smaller and of slighter build. It is at first light yellow in colour, becoming darker-coloured as its outer parts harden.

Description. When mature it is oblong, slightly dilated behind, black, with the elytra anteriorly rufous chestnut, more or less dusky, with antennae, palpi, and feet testaceous, the thighs being paler in colour and the abdomen reddish at the apex. Head tuberculate on the front and punctate. Antennae end in a strongly fan-shaped club, the second joint of the club being about six times as broad as long. Prothorax very convex, culminating in a point medianly on disk, rugose-punctate with a transverse band of rasp-like elevations anteriorly and four teeth on lateral edges of anterior margin; posterior portion depressed, finely rugose-punctate. Elytra truncate, widest apically, strongly rugose-punctate posteriorly, with two sharp teeth on apical declivity. Length, 4 mm. to 5½ mm.

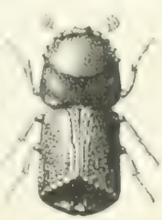


FIG. 113.
Sinoxylon anale, Lesne. Changa Manga, etc.

Larva.—The larva is a little, white, curved grub, with the anterior segments enlarged, and a median dark-coloured line running down the back; three pairs of legs are present. The grub is active in its movements, wriggling about when disturbed. Length, when full-grown, 5½ mm. to 6½ mm.

FIG. 114.
Larva and pupa of *Sinoxylon anale*, Lesne.
Changa Manga.

Pupa.—The pupa has the ordinary white, beetle-like form, which gradually assumes the shape of the mature insect. The head, legs, and wings are pressed on to the under-surface.

Life History.

S. anale appears to have been first discovered in the Bombay Presidency. In February 1891 Mr. F. Gleadow, of the Indian Forest Service, sent specimens of the beetle to the Indian Museum, with the information that it tunnelled into the wood of *Terminalia belerica*. Messrs. T. R. Bell and Andrewes, of the Forest Service, also took the insect, the latter in Belgaum, at light, in March and April, and beneath old bark, the former in Kanara, in the trees *Xylia dolabriformis* and the shisham (*Dalbergia latifolia*). Mr. Bell observed this species boring into the bark of the above-mentioned trees, and then mining out beneath the bark a longitudinal gallery; the female chooses dead trees the wood of which is not quite dry. Mr. Bell found the male and female in the same gallery in March.

From one or more of these Bombay specimens the insect was described by Lesne in 1897. It was in the year 1897 that I first took the insect attacking sál logs in the Singbhum forests of Chota Nagpur. In October 1899 bostrychid beetles were reported from the Changa Manga plantation by Mr. B. O. Coventry, of the Forest Service, which were determined as *S. anale* during a visit I was able to pay to this area in April 1901. Between that year and 1909 a detailed series of continuous investigations into the life history of this pest were carried out. These observations have shown that the beetle is found commonly, although not apparently invariably, attacking trees in company with its larger companion *S. crassum*, already dealt with, and that there are considerable points of resemblance between the life histories of the two insects. Perhaps the most strongly marked differences between the two are to be found in the fact that *S. anale* will apparently attack wood in a drier state than will its companion; and, secondly, that the former appears to pass through a greater number of life-cycles in the year, and to remain longer at work in the autumn and on into the early winter, than does *S. crassum*. This latter point in the life history has been observed in Dehra Dun, and may be accounted for by the fact that we know that the October or early November generation of beetles of *S. crassum* tunnels into the leading shoots and twigs of green sál saplings, a habit which has not yet been traced to *S. anale*, who appears to be a wood-eater pure and simple.

The times at which the different generations of the beetles appear on the wing vary in different parts of the country. In North India (Changa Manga, Dehra Dun, etc.) the beetles issue early in April. In Bombay

they first appear in March, or even February, if the specimens sent by Mr. Gleadow to the Indian Museum were obtained during that month. In Chota Nagpur I have taken them early in March, and they probably appear in February, as this is certainly the case in the Central Provinces. At Katha, in Upper Burma, I found the insect infesting a bamboo on 20 February 1905, whilst what was probably the second generation of the year was taken in "jungle-wood" firewood billets on the launch *Katinka*, as we were running up the Ataran River, on 15 March 1905. The billets were used as fuel for the launch.

In Tenasserim, therefore, the beetle will have completed a generation and a half before the species commences to lay the first eggs of the year in North India. Regarding the period of rest during the winter months, data for the various parts of the country are still required. According to Mr. B. O. Coventry, the last generation of the year appears at Changa Manga in September and October. This observer says that the beetles appear in September and oviposit, disappearing in October. This would seem to show that in the Punjab a portion of this generation passes through the winter in the larval, pupal, or semi-mature imago stage. In Dehra Dun, however, I bred out beetles in the third week of November from sissu billets brought with me from Changa Manga; so that a portion, at least, of the September-laid eggs mature, and hibernate as beetles. I discovered at Changa Manga that these beetles hibernate in the thicker bark of old dying or dead sissu standards. Trees examined were pitted with holes which did not extend down into the sapwood, and had been made only to form a resting-place for the beetle during the winter. As regards the number of generations passed through during the year,

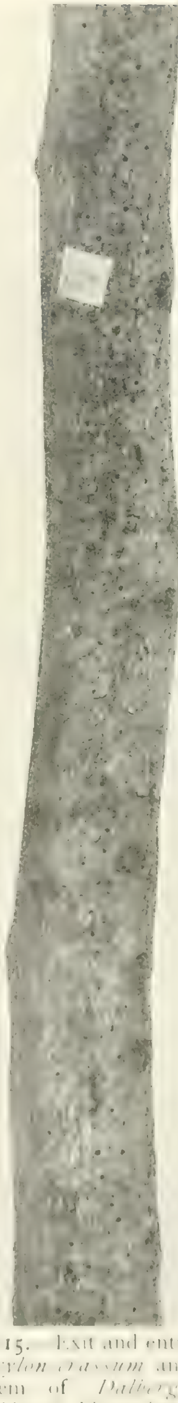


FIG. 115. Exit and entrance holes of *Sinoxylon crassum* and *S. anale* in a stem of *Dalbergia sissoo*. Changa Manga Plantation, Punjab.

in the north of India generally, i.e. the Punjab, the Siwaliks, and sub-montane terai areas of the United Provinces, the insect passes through two and a half to three complete life-cycles, the first eggs being laid early in April. The beetles from these eggs appear in May (I have taken them in the middle of the month at Changa Manga and in the Kumaun sub-montane forests) and in June, laying eggs which give rise to the September (or late August) beetles. These oviposit and produce the third (or partial third) generation, of which some beetles mature and issue in late November.

In the Central Provinces and Bombay the insect appears early in March (or possibly late in February), and it is probable that the insect here, as also in Upper Burma, passes through three and a half to four life-cycles in the year, beetles appearing on the wing and ovipositing in wood in February, early March, middle of April (I have taken them numerously on 14 April in Mandla), July, and September. Finally, in Tenasserim there are possibly four and a half to five generations in the year, the first beetles probably appearing some time in January.

There is a certain amount of overlapping in the generations, owing to the last generation hibernating partly as larvae and pupae and partly as mature beetles. This accounts for my finding mature beetles issuing in the middle of May at Changa Manga, whilst the rest of the generation was still in the larval, pupal, or immature beetle stage. For example, between the 17th and 23rd of the month I found the following in sissu and phulahi trees :—

(*a*) Larvae (a few), pupae, and immature light yellowish-brown beetles in the galleries in the wood.

(*b*) Mature beetles just commencing to tunnel into fresh trees or billets to oviposit. It may be noted here that the beetle is to be found on the wing in the daytime, flying over the bark of standing trees or firewood stacks, or tunnelling into the one or the other.

(*c*) As mature beetles in the wood, well on their way to complete their egg-galleries.

The beetles would thus appear to disregard a hot sun as well as great cold. In the late winter of 1904–5 tremendous frosts were experienced all over the north of India as far down as the Central Provinces. In spite of this fact, I found the insect swarming in the Changa Manga plantations in May 1905, it being that year, perhaps, more numerous than its companion *S. crassum*.

The presence of *S. anale* in a tree or in a billet or log can be easily recognized by :

(1) The beautifully circular entrance orifice.

(2) The white sawdust powder it ejects from the orifice during its tunnelling operations. This, if the outer surface of the bark or wood is at all uneven, is caught up in white masses, and inevitably betrays the presence of the beetle.

To oviposit, the beetle bores straight through the bark (or, if absent, sapwood) until it has got down about a quarter of an inch to half an inch into the sapwood, and then scoops out a deep pit-like gallery which

forms the pairing-chamber. This chamber may have only the one entrance-tunnel (fig. 116, *A*), or there may be two entrance-tunnels into it made by the male and female, as shown in figs. 116, *B*, and 117, *A*. In any event, the male appears to fertilize two females at least, as two egg-tunnels are found to leave this pairing-chamber. These go down at an angle from the pairing-chamber, but are never carried into the heart-wood, this bostrychid being a sapwood feeder only. The eggs are laid at intervals in the egg-tunnel, and the larvae, on hatching out, feed usually in the long axis of the tree or log. The larval galleries, unlike the beetle egg-tunnel, which is kept entirely free from wood-dust and particles, are blocked with wood-dust and excreta throughout their entire length, save for the slight enlargement of the tunnel at the end which forms the pupal chamber. This chamber is blunt elliptical, is free from wood-dust, and is eaten out parallel to the long axis of the tree, as shown in fig. 117, *B*. On maturing, the beetle either eats its way out through the wood and bark above it till it reaches the outside, or, when the wood is badly attacked, eats upwards until it cuts into an empty egg-tunnel, up which it creeps to the outside.

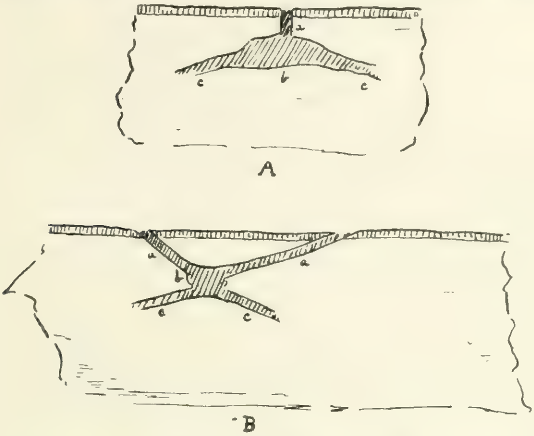


FIG. 116.—*A*, gallery of *Sinoxylon anale* in a khair branch. *B*, galleries in a sissu billet; *a a*, entrance-galleries of ♂ and ♀; *b*, pairing-chamber; *c c*, egg-galleries. Kumaun and Changa Manga. (E. P. S.)

From the above description it is obvious that it is quite easy to distinguish the egg-tunnels made by the beetles from the larval tunnels packed with wood-dust and excreta. These latter are not so easily traced, however, in damp timber as in dry.

Relations to the Forest.

This beetle is one of the most destructive wood-borers in India. Observations have shown that it will tunnel into and oviposit in (1) dying trees, (2) dead trees, (3) fresh-cut logs and firewood billets, and (4) old, dry, or even rotting (if dry) materials.

In infesting wood materials in this manner, the beetle is somewhat exceptional. It is more usual for these wood-borers to confine themselves to wood in a certain stage of humidity, dryness, or decay, and only to attack wood in this condition. *S. anale* does not appear to restrict itself in this manner, for I have taken it in standing dying but green trees in which the flow of sap, though weak, was still making its presence felt, as also in newly dead trees, in old seasoned logs, and in decaying billets. The green healthy tree is not attacked by the beetle, and therefore it cannot be

considered a forest pest save in exceptional cases, when, owing to the enormous abundance of the insect in an area, it would infest and kill off sickly trees, as in the case of the sissu standards attacked by the *Polyporus* fungus at Changa Manga. In such cases, although the beetle is not a bast-feeder in the same way as some of the Scolytidae, the abundance of the bostrychids might result in so large a number of shot-holes being bored through the bark into the sapwood as to further weaken and kill the tree.

Another curious fact about the beetle is that it will attack the wood of the tree anywhere, from the thick knotty wood of the roots, the wood of the main stem, to that of the branches.

To prove that the insect oviposits alike in fresh and in old wood, a fact which has been demonstrated for years past in the Changa Manga Fuel Depot, I took some freshly felled billets of sissu containing ovipositing beetles in April, and bred from them in Dehra the May–June beetles. These latter oviposited in the same billets, from which I obtained a generation of beetles in September. These oviposited in the sissu billets in which their parents and grandparents had been reared, and I obtained some of the beetles of the third generation in the third week of November, the billets being by then very dry, and consisting of little more than powder. This serves as a practical proof of the heavy loss of material which obtains in a fuel depot when the beetle is plentiful and the material is kept *in situ* for any length of time.

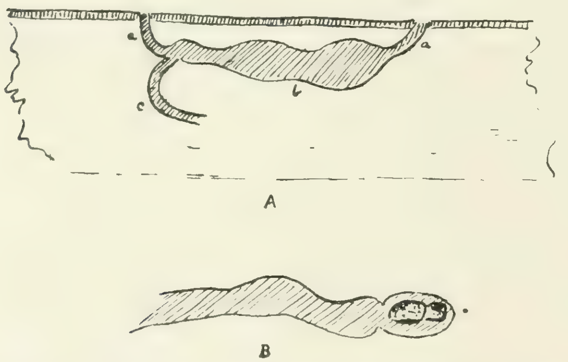


FIG. 117.—*A*, gallery of *Sinoxylon anale* in *Acacia modesta*. *a a*, entrance-tunnels; *b*, pairing-chamber; *c*, one egg-gallery just commenced. *B*, pupal chamber, with immature beetle. Changa Manga. (E. P. S.)

It has been already indicated that the beetle is to be often found attacking wood in company with *S. crassum*. On the whole, so far as present observations go, I should think *S. anale* is the commoner of the two insects, but I make this statement subject to reconsideration after a further study of the two pests.

In addition to the sissu (*Dalbergia sissoo*) and phulahi (*Acacia modesta*) which it badly infests at Changa Manga, the beetle, as we have seen, infests *Terminalia chebula*, *Xylia dolabriformis*, and *Dalbergia latifolia* in the Bombay Presidency, and *Prosopis spicigera* in Sukkur, in Sind. This wood, as mentioned under *S. crassum*, is exported to Quetta for fuel, and the beetles have been taken in that station issuing from the fuel stacks. They do not, however, appear to breed up at that elevation, for I did not find any trace of their attacks in the trees.

In Chota Nagpur and the Central Provinces the insect is to be found infesting sál wood, especially in the beams used in the construction of bungalows. The insect also attacks sál in Dehra Dun, and, I think, *Anogeissus latifolia* posts, both in Dehra Dun and the submontane sál areas. In this part of India it also tunnels into khair (*Acacia catechu*), and may be found in April–May engaged in this manner in trees felled for cutch-boiling. In Mandla, in the Central Provinces, I have also taken the beetle from the wood of *Terminalia tomentosa* and *Pterocarpus marsupium*.

S. anale was taken in Burma by the late Mr. G. Q. Corbett. In 1905 I took it from bamboos (*Dendrocalamus strictus ?*) in the Mohnyin Forest in Katha, from an undetermined species of bamboo on the Salween River in Tenasserim, and from fuel billets of jungle woods on the Ataran River in the same locality. I have not taken the beetle in Madras, nor can I find a report of its existing in the Presidency.

The protective and remedial measures already described for *S. crassum* apply equally to *S. anale*. It must, however, be borne in mind that this beetle will oviposit in much drier wood. Dead standing trees, and accumulations of large branches and tops, and rejected logs left lying in the forest, or stacks of decaying firewood left standing in fuel depots, will attract this pest, and inevitably result in its great increase in the area.

Predaceous Foes.

Most, and perhaps all, of the predaceous insects described under *S. crassum* probably prey also upon *S. anale*, since these two bostrychid borers are commonly found in company riddling wood.

In addition I add the following carabids, which may also attack *S. crassum*, though I have personally only found them preying upon *S. anale*.

Anthia sexguttata, Fabr. (p. 95).—A large black beetle with six large conspicuous white spots, two on the thorax and four on the elytra. The mandibles are powerful, the thorax more or less heart-shaped, and the elytra broad and rounded; legs long and powerful. Length, 43 mm.

Life History.—This large carabid probably feeds upon a variety of insects, and is often found high up on the trunks of trees searching for bark insects and bark- and wood-tunnellers. I took it at Changa Manga towards the end of May 1905, quartering the bark of a large semi-blown-down, still green sissu-tree, which was being riddled by *S. anale* beetles. The carabid was seizing the beetles engaged in tunnelling into the bark to get down into the sapwood. The insect was also, I think, preying upon the *Bothrideres*, *Alindria*, and *Melambia* beetles, which were also ovipositing in company with the *S. anale* and preying on the latter.

FIG. 11[illegible].
Anthia sexguttata. Ho. India.

Scarites bengalensis, Dej. (p. 95).—Elongate, black, with stout prominent mandibles and striate elytra. Head broad, slopes forward, the front depressed on either side of a raised median ridge, the depressions finely and longitudinally striated. Prothorax broader than head, anterior margin concave, with a fine transverse depressed line just below margin; posterior outer angles obliquely truncate, sides straight; disk convex, smooth, dull. Elytra strongly striate, the striae parallel; apices conjointly rounded, surface shining. Length, 15 mm.

Life History.—This beetle preys upon *Sinoxylon anale* in the sissu-tree. I took specimens of the insect from beneath the bark of trees badly infested by the bostrychid at the Changa Manga plantation in May 1905. The beetle is quick in its movements.

Morio subconvexus, Chand. (p. 96).—Elongate, black, shining. Resembles the *Scarites* superficially, but is broader, shorter, and more shining. Head flat, strongly impressed dorsally, mandibles prominent. Prothorax wider than head, anterior angles sharp, sides rounded, constricted behind; disk moderately convex, a median longitudinal impressed line starting in anterior third and reaching base, with two elongate depressions above base, one on either side. Elytra broader than prothorax, striate longitudinally; striae broad; sides straight, constricted apically. Length, 14 mm.


FIG. 119. *Morio subconvexus*, Chand. Changa Manga.

Life History.—The beetle preys upon *Sinoxylon anale* and possibly upon *S. crassum*. I took specimens in company with *Scarites bengalensis* beneath the bark of sissu-trees at Changa Manga.

Sinoxylon atratum, Lesne.

Habitat.—Kumaun, North India; Thana, Bombay.

Trees Attacked.—*Anogeissus latifolia*: Horai, Kumaun; *Acacia catechu*: Thana (G. M. Ryan).

Description.

Beetle.—Very small, elongate, cylindrical. Black, moderately shining. Head finely rugose-punctate. Prothorax convex, transversely ridged medianly, dropping away behind, where it is finely rugose-punctate; anterior part coarsely rugose and rasp-like, the prominences largest laterally and on highest portion of ridge; four teeth, the inner three large and prominent, placed on either side laterally of anterior margin. Elytra widest apically, uniformly rugose-punctate; punctures largest near suture; latter thickened and produced into two small sharp triangular teeth in upper part of declivity. Length, 3.6 to 4 mm.

Life History.

In January 1902 Mr. G. M. Ryan, of the Indian Forest Service, forwarded to me some specimens of this insect from Thana, Bombay, where he had found them tunnelling into branches of *Acacia catechu*. About the middle of April 1905 and middle of May 1908 I took the beetle tunnelling into cut poles and felled logs of *Anogeissus latifolia* in the Horai sál forest in the Terai of Kumaun. This insect was most abundant in April, which is apparently the month in which it makes its first appearance of the year and lays the eggs of the first generation. In May the beetles taken were mostly deep down in the wood at the end of longish galleries which, after entrance into

the sapwood more or less horizontally, turned away at an acute angle as they proceeded deeper into the wood. Only quite small grubs were found near the bottom of the female tunnels. The egg-tunnels go deep down into small poles, and in some cases observed the poles were seriously weakened by the attacks of the beetles.

Sinoxylon indicum, Lesne.

Habitat.—North Coimbatore, Madras.

Tree Attacked.—*Anogeissus latifolia.* Lokanhalle, North Coimbatore.

Beetle.—Small, elongate, cylindrical, dark red-brown, shining. Head black, rugose-punctate. Prothorax very convex, raised into a transverse ridge medianly, the anterior portion coarsely rasp-like, with four teeth on either side of anterior margin, the innermost ones the largest; posterior part finely rugose-punctate. Elytra scarcely widened apically, rugose-punctate, the rugosities coarser in apical portion; declivity rugose-punctate, with two sharp teeth placed centrally one on each side of suture, the outer edges of declivity raised and broadly toothed. Length, 5.5 to 6 mm.

Description.

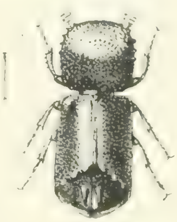


FIG. 120.
Sinoxylon indicum, Lesne. Madras.

Life History.

This insect oviposits in fairly fresh *Anogeissus latifolia* wood. I found the beetle riddling the posts supporting the roof of the veranda of the bungalow at Lokanhalle in North Coimbatore in August 1902. These posts consisted of *Anogeissus latifolia* poles cut and placed in position when the bungalow had been repaired a short time previously, the wood consequently being quite green. The insect was hard at work on the 10th and 11th of the month, engaged in laying its eggs in the wood. On the external surface of the posts round holes were visible, many having small masses of fresh wood-powder at their entrances. The beetle tunnels in horizontally for a distance varying from half an inch to an inch, and then turns to the right or left and eats out a tunnel which curves round the stem, running in a more or less horizontal direction. Near the bottom of this tunnel the eggs are laid. I have not taken the grubs of the insect.

Sinoxylon conigerum, Gerst.

REFERENCE.—Gerst. *M. Berl. Acad.* p. [illegible]

Habitat.—Tinnevelly, Madras.

Tree Attacked.—*Albizzia amara.* Tinnevelly.

Beetle.—Short, squat, and stout, easily distinguished from *atratum* by its much broader and squat appearance. Black, slightly reddish, moderately shining. Prothorax convex, raised on disk; posterior portion finely rugose; anterior rugose-punctate, the rugosities coarsest anteriorly and laterally; four lateral teeth on anterior margin, the inner three large, sharp, and more or less of equal size. Elytra one-third as long again as prothorax, slightly widest apically; rugose-punctate,

Description.

the punctures strongest apically, a short raised longitudinal stria on either side of suture in basal half; the two teeth on elytral declivity stout, pointed, placed at a distance from suture in upper portion of declivity and inclined outwards. Length, 3.5 mm.

This insect was reported in 1908 by the District Forest Officer of Tinnevelly, Madras, as tunnelling into the wood of *Albizzia amara* in July.

Sinoxylon sudanicum, Lesne.

Habitat.—Saharanpur District, North India; Vellore, Madras Presidency.

Trees Attacked.—Dhàk (*Butea frondosa*): Bicharigahr, Saharanpur; Casuarina (*Casuarina equisetifolia*): Vellore.

Description.

Beetle.—Very small. Black, elytra reddish brown; under-surface clothed with a fine long silvery silky pubescence. Prothorax convex, the anterior half rasp-like, the anterior margin with four lateral teeth on either side, the innermost the smallest; posterior half finely rugose, with a sparse fine yellow pubescence laterally. Elytra rugose-punctate, denser near declivity, latter with two small sharp teeth placed fairly close together in upper half. Length, 3 mm. to 3.4 mm.

Life History.

This insect was sent to me from Vellore in Madras in company with other pests of the casuarina. The beetle apparently tunnels into the wood to oviposit. Whether it damages living trees is yet unknown. I cut out some specimens of the insect from the wood of *Butea frondosa* in November 1908 in the Saharanpur District. The beetles were mature in the pupating-chambers.

Sinoxylon tignarium, Lesne.

REFERENCE.—De Niceville, *Ind. Mus. Notes*, v (113).

Habitat.—Darjeeling District.

Tree Attacked.—*Mallotus roxburghianus*. Darjeeling District (C. G. Rogers).

Description.

Beetle.—Short, dark red-brown. Prothorax convex, anterior portion rugose-punctate, denser on sides, the anterior margin with three lateral teeth of more or less equal size, posterior portion finely rugose. Elytra finely rugose-punctate, denser near declivity, latter with the two teeth placed rather close together on either side of suture. Length, 4 mm.

Life History.

Specimens of this *Sinoxylon* were bred out at the Indian Museum from branches of *Mallotus roxburghianus*, sent there in April 1900 by Mr. C. G. Rogers, at the time Deputy Conservator of Forests of the Darjeeling District. Specimens of the infested branches were also sent to me for the collection of forest pests I was getting together that year for the Paris Exhibition. The specimens of the beetle I bred out were submitted to M. Lesne, who notes them as a new species of *Sinoxylon*. Specimens of the beetles bred out at the Indian Museum were sent to Dr. L. O. Howard in

America, who said that the insect figured at the top of page 123 of vol. iii of *Indian Museum Notes* as infesting *Terminalia belerica* was the same species. This insect had been sent by Mr. F. Gleadow, of the Indian Forest Service, as tunnelling into the wood of *Terminalia belerica*. I consider it improbable that the two insects are identical, and in this opinion M. Lesne is in accord with me. He apparently had never seen the Darjeeling species before, for he writes (concerning my specimens): "Il y a parmi ces insectes une forme embarrassante et dont on ne peut guère parler avant d'avoir des matériaux plus satisfaisants." * Mr. Gleadow's insects are, I think, *Sinoxylon anale*.

The specimens bred out at the Indian Museum in 1900, and recorded by de Niceville in vol. v, p. 113, as sent to America, do not appear to have reached M. Lesne.

LYCTUS.

Lyctus spinifrons, Lesne.

REFERENCE.—*Bull. Soc. Ent. Fr.* 303 (1910).

Habitat.—Seoni, Central Provinces.

Tree Attacked.—*Terminalia tomentosa*. Seoni.

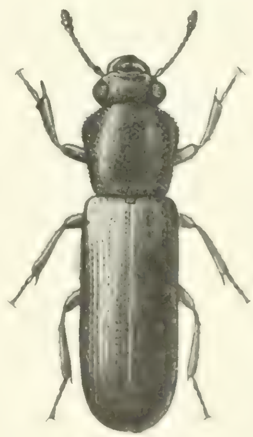


FIG. 121.
Lyctus spinifrons, Lesne.
Seoni.

Description.

Beetle.—Elongate, parallel; ferruginous, testaceous. Dorsal pubescence very fine and dense. Front of head punctate, the punctures containing fine hairs, furnished with teeth. Antenna with joints three to six of funiculus thin, elongated; seven to nine gradually widening; joints of club broader. Prothorax widest in front, where it is slightly wider than elytra; anterior angles toothed, posterior angles very sharp; strongly convex anteriorly, with a median longitudinal line in posterior half; disk punctate. Scutellum shining. Elytra very finely punctate. Abdomen very finely pubescent. Length, 2.3 to 3.2 mm.

Life History.

I took specimens of this insect in September 1901 from galleries in the wood of a *Terminalia tomentosa* post. The post, a section of which is shown in pl. x, was badly infested by *Sinoxylon crassum* and this *Lyctus* and a number of predaceous foes already described.

The insect proved to be new to science, undescribed specimens being present in the Collection A. Grouvelle in the Paris Museum. These had come from Calcutta.

Lyctus sp.

Specimens of a species of *Lyctus* which may be identical with the above were taken from bamboos (*Dendrocalamus strictus*) in Raipur (Central Provinces) in June and in the Siwaliks in September 1901.

* In a subsequent communication M. Lesne informed me that he had identified the insect as *S. tignarium*.—E. P. S.

Family PTINIDAE.

This is a family of small beetles, usually cylindrical in shape, which chiefly requires notice here owing to the powers exhibited by some of the members of drilling into hard seasoned timber, the pin-holes in furniture in Europe being due to the so-called Death Watch, a species of *Anobium*.

Beetle.

In the beetle the tarsi are five-jointed, the first joint not smaller than the second, as in the Bostrychidae. The head can be drawn in under the prothorax, which is at times hood-like, the antennae being slightly clubbed at the top in some species. In colour the insects are dull, chiefly brown or black, although the small *Gibbium* of the teak is bright red-brown.

Larva.

The larva rather resembles the lamellicorn grub (see fig. 46), the last segments of the body being curved, although they are not so bag-like as in lamellicorns, and less strongly corrugated; the head is small, with a two-jointed antenna, and there are three pairs of thoracic legs.

The larva often spins a cocoon at the end of its tunnel, in which it pupates.

The grubs of this family feed on a variety of substances, but only those tunnelling into wood are considered here. Other species riddle books, tobacco (e.g., the common cheroot-borer, *Lasioderma testacea*, Duft.), and dried vegetable materials. The importance of the insects to the forester lies in the fact that some species are serious pests to seasoned timber after its conversion; in this respect the insects also occur as pests in wood museums.

The family is divided into sub-families or divisions :—

1. *Ptinides*, in which the antennae are inserted in the forehead.
2. *Anobiides*, the antennae being placed at the anterior margin of the eyes.

It will be unnecessary here to treat of the insects of these sub-families in detail.

Ptinides.

Ptinus fur, Linn.

This is a small insect of world-wide distribution, which proves one of the commonest of museum pests.

Gibbium scotias, Fabr.

A small wingless insect, very convex above, with joined elytra, brown in colour, shining; one-fifth of an inch in length. It is a common household pest, also widely distributed in the world.

Gibbium sp.

I have taken a small bright red-brown and shining species of *Gibbium* beneath the bark of dead sound teak-trees in Madras, but am unable to say whether it does any damage to the timber.

ANOBIIDES.

Anobium (Litropeda) paniceum, Linn.

This is a small, dull-coloured, oval-shaped beetle, about one-fifth of an inch in length, which is widely distributed throughout the world, and drills the pin-holes in seasoned wood which are so commonly seen in old furniture in Europe. Both the beetle and its larva tunnel in the wood. The small insect which eats out elongate ramifying tunnels in books in the library in India is this *Anobium*.

Trypopithys luteopilosus, Pu. var.

Habitat.—Dehra Dun.

Beetle.—The beetle is elongate, brown in colour, covered with a velvety brown short pubescence arranged in longitudinal lines on the elytra. Head shining, punctate, the mouth with a yellowish-brown brush of hair. It is hidden beneath the hooded prothorax. The latter is convex on the disk, with an elevate, short, longitudinal median ridge basally flanked by a depression on each side ; the sides rounded in front. Elytra broader than thorax, constricted apically, striate, the striae set with short tufts of velvety pubescence. Under-surface darker-coloured, smooth. Length, 6 mm.

Description.

FIG. 122.
Trypopithys luteopilosus, Pu. var. Dehra Dun.

Life History.

I took a specimen of this insect at Dehra Dun on 21 July 1909. The insect fell from the structure of a thatched roof consisting of sál beams, poles, and bamboos. It is probable that the grubs tunnel into one or other of these materials.

CHAPTER X.

POLYMORPHA (*continued*)—MALACODERMATA.

This is a large group, containing an assemblage of insects difficult of definition. The only families here considered are the Malacodermidae, Cleridae, and Lymexylonidae.

Family MALACODERMIDAE.

The general form of malacoderm beetles will be known to many, owing to the fact that the family includes the common so-called firefly (*Luciola*) of the tropics and sub-tropical regions. It contains numerous forest forms, but their life histories and habits require further close investigation before their exact importance can be determined.

Beetle.

The beetles are easily recognized, owing to the fact that the outer covering of the insect is soft, instead of being hard as in most Coleoptera, the elytra having a leathery consistency and usually fitting but loosely together, the insect being elongate and flat in shape, and often dull yellow or brown in colour, although red appears in the family. The head, which is usually hidden beneath the prothorax, bears pectinate antennae (the articulations sometimes modified), the tarsi are five-jointed, and six to eight ventral segments of the abdomen are visible.

In some instances the females are wingless and have the appearance of broad, flat larvae, or the shape of the beetle with short, ill-developed wings.

Larva.

Little appears to be known about the larvae of this family. Members of the division or sub-family Lampyrinae are luminous in some cases. The large, flat, leaf-like larva to be found in the Himalaya, furnished with a small arc lamp at one end of its body, must be known to most foresters serving in that part of India. These larvae are excellently described by Lefroy in *Indian Insect Life* (pp. 321-322). The so-called "fireflies" seen flitting about amongst trees and shrubs and low jungle, more especially during the monsoon months, are species of Lycinae, by name *Diaphanes marginella*, Ho., *Luciola gorhami*, Rits., and *L. ovalis*, Ho.

The forest species of this family in some cases feed on the leaves of trees, and perhaps also on the flowers, whilst others are predaceous, and

more especially in the larval stages. Malacoderms are commonly found on the wing during the day, or resting on the under-surfaces of leaves, etc. Other species will be found crawling or running about over the forest floor beneath the trees. I have taken specimens of the genus *Plateros* ovipositing on teak in the Central Provinces, and committing a certain amount of defoliation by feeding on the parenchyma of the leaf, both in the Central Provinces and in Madras. Other members of the family have been taken between the bark and sapwood of trees. So far, however, investigations do not show that the family is of great importance in the forest.

Classification.

The family is a large one, and consists of a number of sub-families, the Lycinae, Lampyrinae, Telephorinae, Drilinae, and Melyrinae. Its importance in the forest does not justify or necessitate further details on the classification. The species noted as of interest are briefly dealt with below. The genus *Plateros* belongs to the sub-family Lycinae.

Plateros.

Plateros dispallens, Wlk.

Habitat.—Central Provinces.

Tree Attacked.—Teak (*Tectona grandis*). Damoh, Central Provinces.

Description.

Beetle.—Head and prothorax shining black. Prothorax entirely covers the head, wider than long, with a deep sinus running round its edge. Antennae longish, serrate, and shining black, as also are legs; elytra soft, leathery, not meeting rigidly at the suture; rounded at ends. Anterior half of elytra orange-yellow, posterior portion black. Under-surface of insect shining black. Male resembles female in coloration, but latter is slightly larger. Length, ½ in., when fresh. Fig. 123 shows the male and female of *Plateros* sp., to which this one is very similar in appearance.

Egg.—Dirty pale yellow in colour and elliptical in shape. Very small.

Life History.

The insect is to be found on the wing in the middle of August, about which time it pairs. The eggs appear to be laid very soon after pairing, as insects kept under observation laid within twenty-four hours of coupling. The eggs are laid in batches of irregular shape, from thirty to thirty-five being deposited close together in a batch, probably usually upon the teak twigs in the forest, or round and on the buds. The *Plateros* defoliates the teak-trees tc some extent in August, eating patches out of the parenchyma of the upper surface of teak-leaves. As a result, the lower untouched portion of the leaf dies and turns brown.

Plateros sp.

REFERENCE.—This species has not yet been identified.

Habitat.—Central Provinces.

Tree Attacked.—Teak (*Tectona grandis*). Damoh, Central Provinces.

Beetle.—This beetle differs from *P. dispallens* in both size and coloration.

Description. General colour is a reddish-orange beneath, and a russet-brown on head and thorax dorsally. Anterior two-thirds (basal portion) of the elytra, which resemble in consistency and formation those of its smaller companion, russet-brown in colour, the posterior third being black at tips, shading off anteriorly into the russet-brown colour. Legs black, tinged with russet-brown. Antennae longish, serrate, black. Two segments of the body project beyond the elytra. Male smaller than female.

Length of male $\frac{1}{3}$ in., of female $\frac{1}{2}$ in. (measurements of fresh specimens).

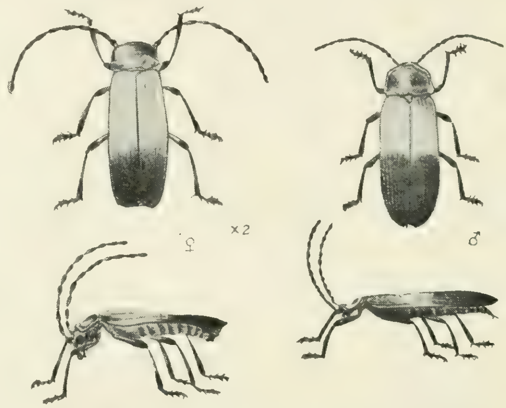


FIG. 123.—*Plateros* sp. ♂ and ♀ beetle. Damoh, Central Provinces.

Egg.—Pure white in colour and egg-shaped, resembling a miniature hen's-egg. Slightly larger than that of *P. dispallens.*

Life History. Specimens of this insect were taken on teak-leaves in the teak forests of Damoh in August, in company with *P. dispallens.* The insects were also pairing and ovipositing, the eggs being laid in irregular patches of thirty-five to forty in each. The life history would appear to be similar to that of *dispallens.* The beetles readily take flight on being disturbed.

Plateros sp.

REFERENCE.—This species has not yet been identified.

Habitat.—South Coimbatore, Madras.

Tree Attacked.—Teak (*Tectona grandis*). Mount Stewart, South Coimbatore.

Beetle.—Elongate, shining golden-yellow; apical third of elytra black. Eyes black, prominent, not very large; antennae eleven-jointed, first four joints yellow, rest black, serrate; legs golden-yellow. Abdomen canary-yellow beneath. Length, $\frac{1}{2}$ in. to $\frac{1}{3}$ in.

Life History.

I took specimens of this insect in the teak forests at Mount Stewart, in Coimbatore, towards the end of July 1902. The beetles were slightly defoliating the trees in a manner similar to that of the species of *Plateros* I had taken the previous year in Damoh in the Central Provinces. The insects obtained had not yet commenced to oviposit, though they were pairing on the trees.

Other species of malacoderms have been taken defoliating teak in this manner in Madras, and the leaves of the Kharshu oak (*Quercus semicarpifolia*) at Deota, in Tehri Garhwal (in June 1902).

ANTHOCOMUS.

Anthocomus ? sp.

Habitat.—Salween River, Tenasserim.

Habits.—I took this small bright-coloured melyrid on a launch off Kowloon Island, in the Salween River, on 9 March 1905. The beetle is very active, and runs rapidly.

I kept the insect in a tube for some days, and placed in with it a *Xyleborus noxius*, Sampson, beetle (p. 600) and several other small beetles belonging to other genera and families. The melyrid attacked and devoured the *Xyleborus*, leaving only the wings and outer shell of the meso- and metathorax. In fact the scolytid was eaten in an exactly similar manner to that in which *Thanasimus himalayensis* consumes bark beetles in the Western Himalaya.

Anthocomus ? sp.

Habitat.—Changa Manga, Punjab.

Trees Infested.—Sissu (*Dalbergia sissoo*), Mulberry (*Morus alba*). Changa Manga Plantation, near Lahore.

Description.

Beetle.—Small, shining. Head black. Prothorax red-brown, the disk black. Elytra black or reddish black with a large yellow spot on basal portion, occupying an area from the lateral margin to near suture and a transverse stripe running from suture to near lateral margin in apical fourth. Head finely punctate. Prothorax smooth and glabrous, widest anteriorly, depressed behind. Elytra duller and uniformly punctate; broader than prothorax behind, widest at level of posterior coxae, thence gradually constricting; apices separately rounded and depressed. Under-surface dull black, punctate. Length, 4 mm. to 5 mm.

FIG. 124.
Anthocomus ? sp.
Changa Manga.

Life History.

I found this small insect in some numbers crawling on and flying over the young coppice areas of sissu and mulberry at the Changa Manga Plantation. The beetle kept for the most part on the young growth near the soil, and was noticed in some abundance between 18 and 22 May 1905. I was unable to determine with any certainty either what it was feeding upon or where the eggs were laid. It may be predaceous upon the *Sinoxylon* wood-borers.

Family CLERIDAE.

This family of beetles must be looked upon as a most important one to the forester, since it contains members which are predaceous upon some of the worst of tree-pests, such as the bostrychid borers of bamboos and the numerous scolytid bark- and wood-borers of coniferous and broad-leaved trees. The clerid beetles in question are predatory in both the larval and beetle stage, the beetle in some cases following its prey into the interior of the tree, in others seeking it outside.

Beetle.

The clerid beetle has a superficial resemblance to a cerambyx or longicorn beetle, the head and prothorax being prominent and narrower than the elytra, the latter having well-marked "shoulders." The antennae are fairly long, with a knob at the end, and the legs moderately long and developed for quick movement in the predaceous forms. The beetles are often brightly coloured, resembling buprestid beetles in this, metallic blues and reds appearing, or, as commonly in some predaceous forms, the elytra are banded with bright bands or spots and patches of red, yellow, black, white, etc. The largest of the forest predaceous forms known is about three-quarters of an inch in length.

Larva.

The grub is elongate, white or pinkish-red in colour in the case of predaceous forms; the head is large, the prothoracic segment of less breadth than the head, and hard and chitinous dorsally, the following segments broader than prothoracic, and increasing in size to the middle and then decreasing to the last, which is constricted abruptly and terminates in two small hooks, probably used in moving about in the tunnels of its prey.

Pupa.

The only clerid pupa I have seen I bred from the grub of the clerid beetle. This pupa was elongate, narrow, with a curious resemblance to the longicorn pupa, the head being vertical as in the lamiid longicorns, white to pinkish-white in colour, the wings and legs pressed against the chest and the antennae on the sides, all these parts white and translucent; rest of pupa a deep reddish-pink, slightly lighter-coloured below; the abdominal segments, eight in number, being broadest medianly and constricted sharply behind, the small spiracles distinctly visible on the sides; the last abdominal segment ends in two minute white processes (see fig. 125).

I am concerned here with the forest predaceous clerids only, but it should be mentioned that some forms of the family are scavengers, whilst others live in the nests of bees, etc.

In the forms here dealt with, the eggs of the beetle are laid by her either in the orifice of the entrance-hole of the bark- or wood-borer or

in a crevice of the bark close by, or she herself enters the tunnel of her prey and deposits the eggs in the egg-gallery of the host.

In the case of the Himalayan *Thanasimus* which preys upon a number of the coniferous Scolytidae, the eggs are laid in crevices of the bark near the entrance-holes of the bark-borers, since the clerid beetle is far too large to enter the tunnel herself. With the bamboo shot-borer beetle things are different. A small species of clerid (*Tillus notatus*) preys upon the bamboo *Dinoderus*, as we have seen (p. 139), and in this case the clerid has the same cylindrical build as the bostrychid beetle, and enters the egg-tunnels of the latter in the wood and oviposits there.

The discovery in 1901 of the Himalayan *Thanasimus* was of considerable interest and importance, since this insect, as is shown in the chapter on Scolytidae (p. 508), occupies a position in the Himalayan coniferous forests exactly analogous to the place occupied by *Clerus formicarius*, the well-known scolytid predator of the European coniferous forests. The Himalayan insect is larger than its European confrère and, if anything, even more carnivorous, the number of beetles devoured by a female of the Himalayan species being extraordinarily large.

I have collected a number of other predaceous clerids throughout the forests of the country, and a study of this important family, or the predator portion of it, in the forest, is eminently desirable. I have not as yet been able to determine the insect or insects preyed upon by my captures in each case. There is a species of *Tilliœra*, however, somewhat resembling the Himalayan *Thanasimus*, which preys upon the Assam sál bark-borer *Sphaerotrypes assamensis* (p. 486), and throughout the country there are doubtless others of equal economic importance.

I lay stress upon the fact that it is desirable that forest officials should have an acquaintance with the more important of the useful predaceous insects, because, in the absence of such knowledge, a campaign of destruction may be carried on against the very insects which it should be the forester's aim, as far as possible, to protect. I remember that on one occasion, up in the Western Himalaya, two forest guards, with a zeal more commendable than the knowledge displayed, brought me a hundred or more dead examples of the valuable Himalayan *Thanasimus* above mentioned. These, they were of opinion, were the insects which were responsible for the sickly condition of some young deodar poles badly infested by *Scolytus*. The gaudy-coloured clerid, flitting about and running over the stems of the trees, was easily visible, and marked down as the author of the destruction, whilst the inconspicuous black-coated *Scolytus* beetle, although present in large numbers, escaped detection.

It did not require very much teaching on my part during the next few days to convert those two forest guards into experts so far as a knowledge of the deodar insect foes and friends present at the period was concerned, and a visit a year or so afterwards showed that they had not forgotten the knowledge thus acquired.

The following predaceous members of the family have been under investigation.

Tillus.

Tillus notatus, Klug.

Reference.—Klug. *Mon. Abhandl. Berl. Acad.* p. 276 (1842).

Habitat.—Bengal and United Provinces.

Habits.—The beetle enters the tunnels of the bostrychid bamboo-borers *Dinoderus minutus* and *D. pilifrons*, and feeds upon their larvae. In May 1903, at the Indian Museum in Calcutta, I fed the beetles on the grubs of *D. minutus*, which they devoured in numbers. The investigations and observations made that year did not show that the clerid beetles feed upon the bostrychid imagos, although the clerid grubs feed upon those of the beetle borer (see p. 139 and pl. ix). I have also taken the insect in the tunnels of *Dinoderos pilifrons* in bamboos in Northern India, where it was engaged in feeding upon the larvae of the bamboo-boring beetle (see p. 133).

Tillus ? sp.

Habitat.—Goalpara, Assam.

Habits.—I took a specimen of this small insect on the grass-reed walls of one of the forest rest-houses in Goalpara, in Assam. The insect is possibly predaceous upon the *Dinoderus* beetles which infest the walls and roofs of these bungalows.

Thanasimus.

A species in this genus takes the place in the Himalayan coniferous forests of the *Clerus formicarius* well known to German forest officers.

Thanasimus himalayensis, Stebbing.

References.—Stebbing, *Jour. Asiatic Soc. Bengal*, lxxii, pt. ii, p. 105 (1903); *Depart. Notes*, i, p. 213.

Habitat.—North-West Himalaya.

Habits.—Predaceous in both larval and beetle stages on the following scolytid and platypid bark- and wood-borers in the Western Himalaya (*vide* p. 508, etc.):—

Scolytidae.

Bark-borers: *Polygraphus major*, Stebbing; *Polygraphus pini*, Stebbing; *Tomicus ribbentropi*, Stebbing; *Tomicus longifolia*, Stebbing; *Pityogenes coniferae*, Stebbing; *Scolytus major*, Stebbing; *Scolytus minor*, Stebbing.

Wood-borers: *Rhyncholus himalayensis*, Stebbing (Cossininae); *Hylastes himalayensis*, Stebbing.

Platypidae.

Wood-borers: *Crossotarsus coniferae*, Stebbing; *Crossotarsus fairmairei*, Chap.; *Platypus biformis*, Chap.; *Diapus impressus*, Jans.

Tillicera assamensis, Stebbing.

REFERENCE.—Stebbing (*Thanasimus*), Some Assam Sál Insect Pests, *Ind. For. Bull.* no. 11, p. 307 (1908).

Habitat.—Goalpara, Assam.

Habits.—The beetle is predaceous in both larval and imago stages on the scolytid sál-tree bark-borer *Sphaerotrypes assamensis* (p. 486).

CLERUS.

Clerus ? sp.

Habitat.—North-West Himalaya.

Tree Infested.—Spruce (*Picea morinda*). Deota, Tehri Garhwal.

Description.

Beetle.—Head and prothorax dark brown, covered with yellowish hairs; prothorax closely punctured. Elytra three times length of head and prothorax, light yellowish brown in colour; a dark brown transverse patch on the apical half reaching to lateral edges, a triangular brown patch on basal area not reaching to sides, above this a narrow transverse band placed diagonally, reaching from edge to suture, the latter part nearest the apex; a large dark-brown patch covering most of the apical half of elytra, but not reaching to apices; this patch reaches the sides, and thins out along suture in direction of the base. Antennae dark brown. Legs long and light yellow. (Insect described from a beetle reared from a larva by myself.)

Larva.—Pink in colour, tapering at both ends and broadest in middle, the last segment ending in two small processes. Mandibles well developed. Under-surface yellowish pink, lighter in colour than upper. Length, 12.5 mm. (Described from a full-grown larva, which pupated shortly afterwards.)

FIG. 125.—*Clerus* ? sp. Larva, pupa, and beetle bred from Spruce. North-West Himalaya. (E. P. S.

Pupa.—Free in pupal-chamber. Head white to pinkish white, vertical; mouth parts, legs, and antennae all distinct, the two latter pressed against sides and chest, free, white to pale translucent. Prothorax pinkish white. Rest of pupa a deep reddish pink, slightly lighter-coloured beneath; abdominal segments visible eight, with spiracles placed laterally, the last segment ending in two minute white processes. Abdomen scalloped laterally on sides. Length, 12.5 mm. The larva pupated on 15 June. On the 16th the wings had already made their appearance, short, membranous, colourless, and pressed close to sides.

Immature Beetle.—On 2 July following the pupa assumed the beetle form. The insect was now uniform in colour, a pale yellowish pink; eyes prominent, black; punctures on elytra visible; the legs and antennae free and functional, although still weak. The beetle matured on 6 July.

Life History.

I have described above the changes which take place in the development of this clerid beetle, from the full-grown larval condition to that of the mature beetle. These were observed by myself during a tour made in Jaunsar and Tehri Garhwal between May and July 1902.

I cut the larva from the thick bark near the base of a large standing girdled dead spruce, which had been, or was at the time, infested by various

scolytid (*Tomicus*, *Polygraphus*) and platypid bark- and wood-borers, and by the wood-wasp *Sirex imperialis* and its parasitic ichneumon *Rhyssa persuasoria*.

The larva is undoubtedly predaceous, and devours the scolytid grubs and also the far larger ones of the *Sirex*. The grub is very alert and active. I found one on a *Sirex* grub, it having penetrated down the long excreta-packed tunnel to get to it. I took another from a small elongate pupating-chamber which it had hollowed out of the thick dry bark of the tree, here about one and a half inches in thickness. The bark-dust eaten out was quite fresh, and the chamber had obviously been just completed, the larva being still active.

I cut out a square of bark containing this pupating-chamber and kept the larva under observation. The grub was discovered on 14 June 1902. It pupated late on the 15th, the pupa being quiescent and motionless. On 1 July following the pupa had begun to assume the beetle form, this change being completed by the 2nd. From this date to 6 July the colour of the insect gradually darkened, the outer integument hardening until, by the evening of the 6th, the beetle was fully developed.

Tenerus.

Tenerus praeustus, Castn. var.

Habitat.—Salween River, Tenasserim.

Tree Attacked.—Teak (*Tectona grandis*). Wutgyi, Salween River.

Beetle.—Elongate, narrow. Head and antennae black, upper joints of latter yellow; prothorax shining canary-yellow or orange-yellow; elytra dull chrome-yellow, the apices black; dorsal surface covered with pubescence; pygidium bright yellow, as also the under-surface; legs yellow, tibiae and tarsi black. Prothorax finely punctate, sides rounded, covered with elongate spiny hairs. Elytra slightly constricted apically, finely rugose-punctate, covered with a short pubescence; apices separately rounded. Length, 9 to 14 mm.

Description.

Life History.

I took a specimen of this small beetle beneath the bark of a freshly felled green teak-tree, in a tounggya clearing at Wutgyi, on the Salween River, in the first week of March 1905. The beetle was mature, the pupal stage having been passed in the tree. I have no further information on its habits.

Tarsostenus.

Tarsostenus univittatus, Rossi.

Reference.—Rossi. *Fn. Et. Mant.* i, p. 44.

Habitat.—North India.

Habits.—I took a specimen of this insect in my office at Dehra Dun. It fell from the thatched roof, which consisted of sál beams and a bamboo superstructure, the former badly infested with the *Sinoxylon* wood-borers *S. crassum* and *S. anale*, and the latter by the bamboo-borer *Dinoderus pilifrons*. It is possible that this beetle was predaceous upon the latter insect (see p. 132).

Family LYMEXYLONIDAE.

The mature beetles of this family are elongate and cylindrical, resembling malacodermid beetles, with short serrate antennae and five-jointed tarsi, the first and fifth joints of which are long.

The larvae are very elongate and cylindrical, almost worm-like in appearance, and white in colour, and tunnel in dead wood.

The family is of doubtful importance in the forest at present. Some years ago at Dehra Dun a log of wood which we considered to be *Anogeissus latifolia* was submitted to me by Mr. A. M. Caccia, M.V.O., of the Indian Forest Service. This log was riddled with the circular tunnels of lymexylonid larvae, the grubs being present in large numbers. Unfortunately, during a prolonged absence of several months on tour, an accident happened to the log and I secured no beetles from it, and I was thus unable to procure the identification of the species.

Both in Assam and Burma I have found lymexylonid grubs in the wood of various dead trees, but I have never as yet bred beetles from them.

CHAPTER XI.

POLYMORPHA (*continued*)—Family BUPRESTIDAE.

THE Buprestidae, or buprestid beetles, are well known, owing to the brilliant metallic colouring of many of the members of the family. This brilliancy is not merely to be found on the elytra, but often extends to the whole of the insect both dorsally and ventrally, greens, blues, reds, purple, copper, and yellows being found, the shades being light or dull to black. In India the brilliant outer wing-cases have a peculiar fascination for a people naturally addicted to bright colours, and they are used in adorning various articles of apparel, and even employed as caste marks in the south. The beetles are nearly always covered, when alive, with a white, yellow-ochreous, or reddish purulence, often mistaken for the pollen of flowers, and this is sometimes retained by a pubescence which may entirely clothe the insect or be placed in thick patches in depressions and foveae.

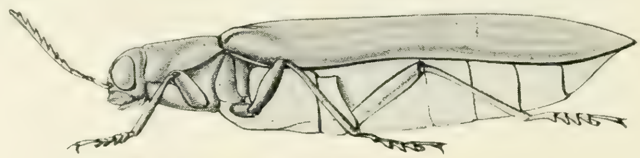


FIG. 126.—*Catoxantha bicolor*, Fabr. Burma and Assam.

The beetles vary in size, the length averaging from 1 mm. to 70 mm.

Beetle.

The shape is usually what is known as torpedo-shape, varying from ovoid elongate to navicular, pentagonal, or sub-triangular, the greatest width being usually at the shoulder, whilst they are constricted behind, the elytral apices being often spined. The head is short and vertical, embedded in the prothorax to the eyes, the latter being elliptical, and either parallel or set obliquely, the upper or lower ends approaching one another. The antennae are of importance in the classification of the family; they are inserted on the front of the head, are eleven-jointed and serrate, the joints being furnished with pores diffused on one or both faces, or concentrated in a fovea on the lower margins or at the extremity.

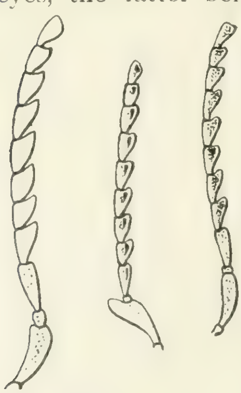


FIG. 127.
Buprestid Antennae.

The mandibles are short, stout, and thick. The prothorax is variously shaped, more usually transversal and cylindrical-conical, the anterior and posterior margins being straight or bisinuate or emarginate or the latter with a median lobe, the sides often oblique or rounded. The scutellum is very variable, and is sometimes invisible (*Chrysochroa*). The elytra entirely

cover the abdomen or leave exposed the pygidium; the lateral apical edges are often toothed, at times to as much as half the total length of the elytra, or the apices are merely spined. The lower wings are wide, longitudinally folded at the base and transversely at the summit. The prosternum is rigid and prolonged behind, fitting into the mesosternum or even the metasternum. The legs are relatively short, the tibiae usually slender with two small terminal spurs; the tarsi are five-jointed, the first four joints with more or less developed membranous appendages beneath; claws unarmed.

The beetles, when they feed at all, usually eat the parenchyma of leaves, or strip the young green bark off shoots and young branches. They fly during the day, and may be seen sitting on leaf or stem in the hottest sun. When at rest the beetles are not so easy to see, since mimicry and protective resemblance are common in the family, the coloration of the insects often resembling that of the flower, leaf, or twig to which they are clinging. They also often sham death, and are aided in this by being able to hide away legs and antennae in cavities.

Larva.

The larva (fig. 30, *c*) is white or yellowish-white in colour, legless, with a black or brown horny head, and a yellow or orange prothorax which has a characteristic and remarkable shape. The head is very small, and is almost entirely withdrawn into the broad prothorax, this latter being often flat or circular, and very much larger than the segments which follow it, usually having a hard plate on the dorsal surface; the segments following the prothorax are generally narrow and slender, some of the posterior ones being doubled back on the others when the grub is feeding in its burrow (cf. pl. xiii). This disparity in size between the prothorax and following segments serves to distinguish easily this grub from that of the Cerambycidae, in which the body segments more nearly approximate in width to that of the prothorax.

The grubs of the forest species known feed in the bast layer and sapwood of trees, eating out winding, shallow, broad tunnels, which are packed with their excreta and wood-refuse. When full-fed they penetrate a short distance into the sapwood, and eat out a pupal chamber there. The larval life may last for a few weeks only, or may extend to nearly a year.

Pupa.

The buprestid pupa (fig. 31, *b*) presents few differences in appearance from that of the ordinary coleopterous nymph. It is white or yellow in colour, flat and often rather squarish in shape, the anterior wing-cases and legs pressed to sides and breast. The pupa spends a few weeks only in this stage of its existence, in the case of the smaller species the period being perhaps from ten days to a fortnight. The beetle, however, rests for a varying period in the pupal chamber before it leaves the tree.

Damage done by the Family.—Observations at present point to the fact that

FIG. 128.—Larval galleries and entrance-holes to pupating-chambers of a buprestid (*Chrysobothris*) in sapwood of sál. Kumaun, United Provinces.

the damage done by this family in the forest is chiefly to the bast layer of the tree. In the case of all the species so far studied, the beetle lays its eggs in the bast or in a crevice of the bark, whence the young grub can quickly reach the bast. The grubs feed entirely in the green bast and outer sapwood, eating out wide, shallow galleries which groove both. Consequently, when the grubs are numerous these galleries cross one another, and the tree is finally girdled and killed. Observations have shown that there are several of the smaller Buprestidae, such as the *Sphenoptera* of the deodar (p. 204), the *Anthaxia* of *Pinus longifolia* (p. 212), which are capable of becoming serious pests to these trees. European examples from the same family form object-lessons which it will be advisable to remember in India.

Classification. The family may be divided into twelve sub-families, of which eight only fall within the Indian region, viz. the Julodinae, Polycestinae, Chrysochroinae, Chalcophorinae, Chrysobothrinae, Sphenopterinae, Buprestinae, and Agrilinae. Of these eight sub-families seven are known to contain pests of importance in the forest, these being the Polycestinae, Chrysochroinae, Chalcophorinae, Sphenopterinae, Buprestinae, Chrysobothrinae, and Agrilinae

Sub-family POLYCESTINAE.

Antennal pores collected in a lower or terminal pit. Scutellum almost invisible. Clypeus large, triangular. Posterior coxae but slightly dilated on their inner surfaces, their posterior margins slightly oblique or sub-sinuous. Tarsal claws simple, bilobed or toothed.

This is a rather small sub-family in India. Genera contain species of importance in the forest.

ACMAEODERA.

Acmaeodera belli, Kerrem.

REFERENCE.—Kerrem. *Ann. Soc. Ent. Belg.* xxxvii, 338 (1892).

Habitat.—Kanara, Bombay Presidency.

Tree Attacked.—Unknown.

Beetle.—Brilliant bronze above, black beneath, covered with a scattered, short, whitish pubescence, densest at apex of elytra. Prothorax nearly as wide as long, the anterior margin sinuate, with the median lobe produced and broad; densely punctate. Elytra as wide as prothorax at base, slightly wider in apical half, thence constricted to apex; apices moderately rounded and finely toothed; rugose-punctate, with longitudinal series of deep punctures, the basal half with longitudinal striae. Length, 4 mm.; breadth, 1.25 mm.

Description.

A specimen of this beetle was taken on the wing in the Kanara forests by Mr. T. D. R. Bell, I.F.S. Nothing further appears to be known on the subject of its life history.

Acmaeodera stictipennis, Cast. et Gory.

(The Small Sál Buprestid.)

REFERENCE.—Cast. et Gory, *Mon. Bupr.* i, 26, pl. 8, fig. 45 (1835).

Habitat.—Siwalik Sál Areas, United Provinces. Also reported from Mhow; N. Bengal, Maldah; Konbir, Tetara (P. Cardon); South India, Bangalore, Malabar.

Tree Attacked.—Sál (*Shorea robusta*). Dehra Dun and Saharampur Sál Areas.

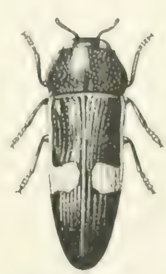


FIG. 129. *Acmaeodera stictipennis*, Cast. et Gory. Siwaliks.

Beetle.—Deep metallic blue, elytra with a red patch. Prothorax finely punctate, with a slight depression on disk and one on each side. Elytra elongate, constricted at apices; the deep punctures set in longitudinal striae; a red patch commences at base of outer angle and runs along the lateral margin to middle, where it widens out across the elytra, but does not meet the suture. Under-surface pubescent. Length,

Description.

8 mm. to 10.25 mm.; breadth, 3 mm. to 5.25 mm. The deep indigo-blue colour and the red elytral patches easily serve to distinguish this insect.

Larva.—A small, elongate, white, flat grub, with a greatly developed chitinous orange prothoracic segment.

Life History.

The first beetles of the year appear about June in North India, and lay eggs on the bark of green branches of the sál-tree, or on the main stem of young trees. The larva, on hatching out, feeds in the cambium layer and outer sapwood, grooving out winding galleries which take the direction of the longitudinal axis of the branch or stem. These galleries are several inches in length, and are blocked with the wood-dust and excreta of the larvae. When full-fed the grub bores down deeper into the sapwood, eating out there a small pupating-chamber. The pupating-chamber and entrance-tunnel to it are free of wood-dust and excreta. On maturing, the beetle crawls up the tunnel, bites its way through the bark, and escapes from the tree.

Only in June have I taken beetles on the wing. The first beetles obtained I bred out from nearly full-grown larvae taken in sál branches in the Siwalik Forest Division in February–March. These grubs pupated in April and the beetles issued in June. I have taken larvae in the trees in September, and am of opinion that a second generation of this insect issues some time in October or early November. The winter is passed through in Northern India in the larval stage.

Damage Committed in the Forest.

The danger of these small buprestids when they infest broad-leaved trees is greatest in areas of young growth which from one cause or another are in a sickly condition. For instance, I noticed that the insect was in considerable abundance (in company with the sál *Sphaerotrypes*, see p. 476) in the sál areas in the Siwaliks and neighbouring forests to the east of the Ganges, which suffered so severely from the great frosts of February 1905. The insect also infests trees which have suffered under the heavy defoliating attacks of *Suana concolor*, especially when these are combined with those of the *Monophlebus* scale pest, as is so often the case when the latter insect is swarming in the forest.

It is the habit of this buprestid of infesting in numbers sickly trees which would otherwise recover that makes it necessary that its appearance and life history should be well known to the Forest Officer.

Since the habitat of the insect stretches outside the area over which the sál-tree is found, it is obvious that it must infest other species of trees in addition to the sál.

Chalcid.—Specimens of a small chalcid fly, at present undetermined, were bred out with some of this buprestid from infested sál branches. The grub of the fly probably feeds parasitically upon the buprestid larvae.

Acmaeodera Kerremansi, sp. nov. Steb.

Habitat.—Changa Manga, Punjab.

Tree Attacked.—Sissu (*Dalbergia sissoo*). Changa Manga Plantation, Punjab.

Beetle.—Head black, prothorax black, the lateral edges orange, not reaching to anterior margins. Elytra black, traversed by numerous transverse wavy orange bands and spots, and covered with a short fairly dense white pubescence. Head finely rugose. Prothorax flattened medianly, wider than long, anterior margin sinuate, median lobe wider, produced; strongly and uniformly punctate. Elytra as wide as prothorax at base, widest in apical half, rather strongly constricted at apex; apices rounded, toothed; punctate, the punctures set in longitudinal striae which are deepest apically, becoming almost obsolete towards base. Length, 6.5 mm.; breadth, 1.75 mm. The curious transverse zig-zag orange markings on a black background of the elytra serve readily to distinguish this beetle which is figured in pl. xv, fig. 1.

Description.

Specimens of this buprestid, which is new to science, and which I take pleasure in naming after that great entomologist, my friend Monsieur C. Kerremans, were cut out of their pupating-chambers in dying sissu-trees at the Changa Manga Plantation on 17 and 18 May 1905. One of the beetles had left the pupating-chamber and had crawled up the entrance-tunnel and bored through the bark before, from some unknown cause, it died. The larva feeds in the cambium layer, where it eats out a winding gallery. When full-fed it tunnels into the sapwood to pupate, the entrance-tunnel leading to the pupal chamber being carried down at an angle. The eggs are laid on dying and newly felled trees, the main stem and larger branches being attacked, moderately thick bark being required for the sustenance of the grubs.

Life History.

Sub-family CHRYSOCHROINAE.

Antennal pores diffused over both faces of the joints; posterior femora nearly contiguous, dilated on the inner side, compressed anteriorly by a lateral prolongation of the abdomen, their anterior margin sinuous, the posterior oblique for the greater part and truncate on inner side; first joint of posterior tarsi longer than the following one; scutellum invisible.

This is a large sub-family, containing some of the biggest of the Buprestidae known in India. Many of them are brilliantly-coloured, handsome insects.

CATOXANTHA.

The elytral costae are thick and prominent. The genus contains some of the largest known Indian buprestids.

Catoxantha opulenta, Gory.

REFERENCE.—Gory, *Rev. Mag. Zool. Ins.* 17 (1832).

Habitat.—Chittagong Hill Tracts. Also reported from Borneo and Penang.

Trees Attacked.—Jarul (*Lagerströmia Flos-Reginae*); Chikrassi (*Chickrassia tabularis*). Chittagong Hill Tracts.

Beetle.—Head and prothorax bronzy; front of head and sides of prothorax fiery red; latter with a greenish reflexion medianly; the elytra dark indigo-blue, the base purple, the basal half with a coppery-purple reflexion, the apical half with a greenish-blue one which is specially prominent at the apices; a transverse yellow band crosses each elytron about the centre. Under-surface of pro- and mesothorax fiery red, as are the coxae of the posterior pair of legs. Antennae bronzy violet. Abdominal segments yellow, with a lateral black patch in upper outer angle of each. Head channelled down middle. Prothorax as wide as head anteriorly, entirely covering scutellum posteriorly, where it is narrower than the elytra. Elytra constricted from posterior coxae to apex; latter emarginate with a sutural spine; the elytral costae are longitudinally parallel and dark-bronze coloured; the yellow band does not reach the suture on the outer edge. Length, 45.5 mm. to 66.5 mm.; breadth, 16.5 mm. to 21.5 mm.

Description.

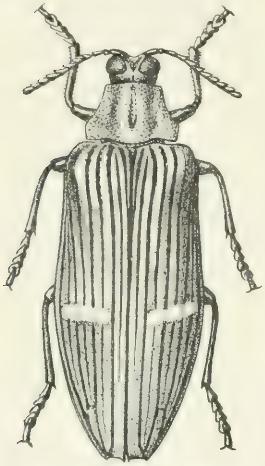


FIG. 130.—*Catoxantha opulenta*, Gory. Chittagong Hill Tracts.

The above description, which was made at the time from fresh beetles taken by myself in the Chittagong Hill Tracts, differs slightly from that of Gory, the differences being probably due to his specimens being dried ones. My specimens averaged 55 mm. in length and 20 mm. in breadth. So far as I am aware, this is the first report of the insect from the Indian region.

Life History.

The grubs of this beetle feed in the bast and sapwood of, I believe, several species of trees. I have cut out beetles from the pupal chambers in the jarul (*Lagerströmia Flos-Reginae*) and chikrassi (*Chickrassia tabularis*), and Mr. A. H. Mee, of the Bengal Provincial Forest Service, took specimens from other two "jungle" trees in the hill tracts, the names of which he did not, unfortunately, record.

Long, broad, shallow, winding galleries are eaten out by the grubs in the bast and sapwood, the whole of the bast layer being at times riddled by them. The beetles appear on the wing in late May in the Chittagong Hill Tracts, at about the period of the bursting of the monsoon. The larvae feed in the tree either till the beginning of December, when they pupate, or they pass through the cold weather in the larval stage, pupating in February or March.

It is probable that the beetles continue issuing over a period of two or more months, as I think specimens of this insect have been noticed on the wing in July.

Catoxantha bicolor, Fabr.

REFERENCES.—Fabr. *Syst. Ent. App.* 825 (1778); var. *nigricornis*, H. Deyr, *Ann. Soc. Ent. Belg.* viii, 1 (1864); *assamensis*, Thoms. *Bull. Soc. Ent. Fr.* (5), ix, 70 (1870); var. *cyanura*, Kerrem, *Ann. Soc. Ent. Belg.* xxxvi, 171 (1892); var. *gigantea*, Scopoli, *Ann. Hist. Nat.* 104 (1869); Schaller, *Act. Acad. Nat. Cur. Halle*, 304, pl. i, fig. 5; *heros*, Wiedmann, *Zool. Mag.* 99 (1823); var. *brunnea*, Saunders, *Trans. Ent. Soc. Lond.* 3, pl. i, fig. 1 (1866).

Habitat.—Rangoon Division, Lower Burma; Buxa Duars. Also reported from Himalaya; Allahabad, Darjeeling, Kurseong; Mungphu,

Sikkim; Sylhet, Naga Hills; Lower Burma; Siam; Java; Luzon; Sumatra; Borneo.

Trees Attacked.—Pyinkadu (*Xylia dolabriformis*): Rangoon Forests; ? Sál (*Shorea robusta*): Rajabhatkhawa, Buxa Duars.

Description.

Beetle.—Elongate, very large. Brilliant metallic green, blue, or purple; prothorax in green specimens may be blue or green, the lower outer angle always yellow; two transverse oval yellow patches on apical portions of elytra a little below centre. Head is deeply furrowed. Prothorax much dilated laterally at hind angles, these latter being swollen up into prominent lobes orange-yellow in colour. Elytra smooth, with four narrow more or less prominent longitudinal lines down them; the yellow transverse patch varies in size, but never reaches to either the suture or the outer margin. Length, 55.5 mm. to 77 mm.; breadth, 18.5 mm. to 25 mm. The curiously swollen posterior outer angles of the prothorax, only present in this species, are sufficient to identify it. The following varieties of this insect are distinguishable:—

var. *gigantea.*—Head and prothorax dark metallic blue; elytra dark green; the yellow elytral patches rather small, and surrounded by an irregular dark-blue marginal band, the yellow basal angular lobes large. This variety reaches 77 mm. in length, and specimens are recorded from the Himalaya, Allahabad, and Sikkim.

var. *cyanura.*—Head and prothorax dark bronzy; elytra dark purple, yellow elytral patches large; basal angular lobes of prothorax much swollen. Specimens in the British Museum measure as much as 62 mm. It comes from Sikkim.

var. *brunnea.*—Whole insect metallic coppery. Recorded from Siam.

var. *nigricornis.*—Resembles *gigantea*, but has more elongate basal angular lobes on prothorax, and narrower transverse yellow elytral patches. Reported from Borneo.

Although this species thus varies greatly in coloration, no specific characters have so far been distinguishable amongst the many varieties. The marked differences in colour cannot be made use of, since intermediate stages, where the one colour appears to be merging into the other, are present in the fine British Museum series of individuals of this insect.

FIG. 131.—*Catoxantha bicolor*, Fabr. Burma and Assam.

I have described the varieties at length to avoid the confusion which might otherwise arise. For the purpose of the Forest Officer, the specific name of *bicolor* may be considered sufficient at present to indicate the species wherever met with in India.

Larva.—The larva is elongate, yellowish white, with stout black mandibles, and a well-developed prothoracic segment furnished with a hard orange plate on the dorsal surface; the segments following the prothoracic one are much narrower, the posterior ones constricted slightly. Length, 87 mm.

Life History.

The larvae of this insect have been taken tunnelling in the bast and sapwood of the pyinkadu-tree, in the Lower Burma forests. It is possible that it lives in other trees in this region. On becoming full-fed the larvae tunnel down into the sapwood

and pupate there. The beetle leaves the trees and appears on the wing in the forests in March and April.

I took the beetle on a sál-tree on 30 May 1906 in the sál forests near Rajabhatkhawa, in the Buxa Duars. I have never yet found its larvae in the sál-tree.

Owing to the wide distribution of this buprestid, it is probable that the insect infests a number of different kinds of trees.

CHRYSOCHROA.

Differs from the last in having a transverse depression on each side of the prothorax; the under-surface of the body is metallic, with metallic reflexions.

Chrysochroa vittata, Fabr.

REFERENCES.—Fabr. *Syst. Ent.* 216 (1774); *aurea*, De Geer, *Mém. Ins.* vii, 634, pl. 47, fig. 15 (1778); *ignita*, Herbst, *Arch. Ins.* v, 117, pl. 28*a*, fig. 3 (1784); *chinensis*, Voet. *Cat. Col.* 93, pl. 48, fig. 2 (1808).

Habitat.—Chittagong Hill Tracts. Also recorded from Assansol, Bombay Presidency, Siam, China.

Trees Attacked.—Jarul (*Lagerströmia Flos-Reginae*); Chikrassi (*Chickrassia tabularis*). Chittagong Hill Tracts.

Beetle.—A brilliant blue with green reflexions, or brilliant green; posterior angles of prothorax golden coppery or fiery red; elytra with a golden coppery longitudinal stripe running down from the shoulder to near the apex; antennae purple; under-surface metallic green with a coppery reflexion; abdominal segments coppery, shining medianly, with a dense yellow pubescence at sides, where there is also a greenish reflexion. Head deeply and widely excavate, the excavation prolonged to meet the anterior margin of prothorax. Latter a little more than one and a half times as broad as long. Elytra wider than prothorax, truncate at shoulder, constricted at apex; latter truncate, bidentate; the suture and four raised costae on each elytron approaching each other towards apex; the golden coppery band of colour runs chiefly between second and third costae, stretching into first and second near apex. Legs metallic green. Length, 34 mm. to 45 mm.; breadth, 11 mm. to 15 mm.

Description.

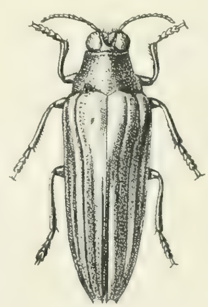


FIG. 132. *Chrysochroa vittata*, Fabr. Chittagong Hill Tracts.

Life History.

I took specimens of this beetle towards the end of May from pupal chambers in the sapwood of jarul (*Lagerströmia Flos-Reginae*) and chikrassi (*Chickrassia tabularis*) trees in the Chittagong Hill Tracts together with the *Catoxantha opulenta* already considered. These two beetles evidently lay their eggs in the same trees, and the larvae tunnel in the bast and sapwood in a similar manner, and probably have a very similar life history.

Since this insect has been recorded from Assansol (in Bengal) and from the Bombay Presidency, it must infest several other species of trees.


a
b
c
d
e
f

Sub-family CHALCOPHORINAE.

Antennal pores scattered over both faces of the joints, never concentrated in a single pit or fovea. Scutellum invisible.

The sub-family contains two genera of some importance in the forest, *Psiloptera* and *Capnodis*. The brilliant metallic beetle *Psiloptera fastuosa* has a wide range and is well known. The genus will in all probability be found to contain several forest pests. *Capnodis*, a dull black-coloured genus of characteristically shaped beetles, though probably less well known, is very easy to recognize, and contains two or three species of importance.

Psiloptera.

Psiloptera fastuosa, Fabr.

References.—Fabr. *Syst. Ent.* p. 216 (1774); Cast. et Gory, *Monogr.* i, p. 14, pl. 22, fig. 114; Lushington and Stebbing, *Indian Forester*, vol. xxxi, p. 74 (1895).

Habitat.—Berar, Malabar. The distribution is wide, the insect being reported from Belgaum, Kanara (Bell), Mhow, Central India, Calcutta, Madras, Neilgherries, China.

Trees Attacked.—Babul (*Acacia arabica*): Buldana, Berar; Teak (*Tectona grandis*) and Mahogany (*Swietenia macrophylla*): Nilambur Plantations, Malabar.

Beetle.—Oblong, brilliant metallic, coppery or deep bluish coppery; elytra medianly almost invariably coppery, merging into green or golden green, or green followed by a deep blue on the lateral edges; under-surface coppery. Head rugose in front, punctate on vertex, latter with a slight median line. Antennae coppery. Prothorax two-thirds as long as wide, widest at middle, bisinuate behind with a smooth median longitudinal line, often absent; disk sparsely punctate, punctures denser on lateral edges, which are occasionally rugose. Elytra three and three-quarters as long as prothorax, scarcely wider at base; disk smooth, finely punctate, rather densely striate-punctate laterally; base slightly rugose; apex truncate with a small spine in each angle. Under-surface punctate, punctation fine and dense in patches on lateral edges. Legs and tarsi coppery. Length, 17.5 mm. to 27.5 mm.; breadth, 7 mm. to 10.75 mm. Pl. xi, figs. *a*, *b*, *c*.

Description.

Life History.

In *Indian Museum Notes* * allusion is made to the fact that specimens of the beetle were forwarded from the Madras Museum with the report that the insects were injurious to the great teak plantations at Nilambur, Malabar, by boring into the wood. Nothing further is on record, but presumably the injury done to the wood would be by the larvae.

More recently Mr. P. M. Lushington, I.F.S., published a paper in the *Indian Forester* † on the insect pests of *Swietenia macrophylla*. One of them, identified as *Psiloptera fastuosa*, was said to feed on the leaves of young mahogany, causing defoliation. Perhaps the insect fed on the bark of twigs, thus causing the leaves to drop.

* *Ind. Mus. Notes*, vol. ii, p. 45.

† *Ind. For.* vol. xxxi, p. 74.

With his report on the destruction caused by beetles to babul in the Buldana Plantation in November 1907, Mr. Srinivasalem Naidu, the Divisional Officer, forwarded numbers of beetles of two kinds. The one proved to be *Coelosterna scabrata* (p. 358), the other *Psiloptera fastuosa*. This beetle appears on the wing in November in Berar, is apparently very abundant, and injures the stems of the trees by peeling off the bark. The damage done to the young stems of babul is easily distinguishable and is shown in pl. xi.

Neither the eggs nor larvae have yet been discovered. It is probable, I think, that they are laid on the stem, and that the grubs feed in the bast layer and outer sapwood, mining out flat irregular galleries here. Many members of this genus feed in this way, and it is in this position that the grubs should be searched for.

It is of considerable importance that the full life history of this insect should be worked out, so that the significance of its appearance with *Coelosterna scabrata* in the babul plantations may be ascertained.

Mr. J. D. R. Bell, I.F.S., has reported that the beetle is excessively common in Kanara during the monsoon in August and September.

Psiloptera coerulea, Oliv.

REFERENCES.—Oliv. *Entom.* ii, gen. 32, 21, pl. 4, fig. 35 (1790); Gemm. et Harold, v, 1365.

Habitat.—Belgaum, Kanara (Bell). Also taken in Pondicherry and Ceylon.

Tree Attacked.—*Acacia arabica*. Belgaum, Kanara (Bell).

Beetle.—Resembles *fastuosa* in shape, size, and punctation. Blue or blue-green, dull. Head green. Elytra with a golden-red or crimson band medianly. Prothorax with a transverse median depression just above basal margin. The band of colour on elytra either broad or narrow, merging into green on sides and then into deep blue on the lateral margins. A triangular patch of yellow pubescence in lateral upper corner of abdominal segments. Legs green, tarsi bronze-green. Length, 16.5 mm. to 26 mm.; breadth, 6 mm. to 10.25 mm.

Description.

Easily distinguishable from *fastuosa* by the totally dissimilar colouring above and beneath, and in the triangular patches of yellowish pubescence on the abdominal segments. In *fastuosa* the pubescence usually covers the whole of this region.

The insect has been taken on *Acacia arabica* trees during the rainy months.

Psiloptera viridans, Kerremans.

REFERENCE.—Kerremans, *Ann. Soc. Ent. Belg.* xxxvii, 329 (1893).

Habitat.—Mandla, Central Provinces. Also reported from Kanara, (Andrewes) and Sylhet.

Trees Attacked.—Sál (*Shorea robusta*); *Terminalia tomentosa*. Banjar Valley, Mandla.

Beetle.—Oblong-oval, elongate; brilliant green, with the suture golden; under-surface brilliant coppery with green reflexions. Head flat with big punctures. Prothorax deeply and irregularly punctate, dense on sides. Elytra scarcely wider than thorax at base, slightly sinuate on anterior margins, and abruptly constricted from upper third; obliquely truncate and two-spined at apex; set with longitudinal rows of deep punctures, between which are smaller ones formed of small clusters of minute punctures, mostly irregularly spaced. Under-surface deeply rugose-punctate, with thick patches of pubescence on lateral edges of abdominal segments. Legs coppery, punctate. Length, 14 mm. to 23 mm.; breadth, 4.5 mm. to 7 mm.

Description.

Larva.—Elongate, white, with a small yellow head and an enlarged prothoracic segment. Length, 30 mm. to 36 mm.

Life History.

In the Mandla forests of the Central Provinces on 13 April 1909 I took numbers of the grubs of this buprestid feeding in galleries in the bast and sapwood of a large green *Terminalia tomentosa* tree which had been felled in the previous February.

The grubs were accompanied by *Sphaerotrypes globulus* (p. 487) in parts of the tree. The larvae were mostly full-grown, and many had already eaten the pupating-chamber deeper down into the sapwood. The larval gallery is long, irregular, and winds about at different angles; it is broad, and packed with wood-dust and excreta. The pupating-chamber is eaten out parallel to the long axis of the tree, and is connected with the larval gallery in the sapwood and bast by a short tunnel from half an inch to one inch in length.

I subsequently took the larvae numerously in the felled sál-trees in the Banjar Valley of this district. Large individuals of both species of trees had been felled on the alignment of a new road running through these forests.

The insect probably passes through the earlier part of the winter in its pupating-chamber in the tree as a pupa, or nearly mature beetle, appearing on the wing in February and ovipositing in the trees. This is borne out by the fact that I took a dead fully mature beetle in a pupal chamber in the sapwood of a tree felled the previous year, and a living beetle on the wing, probably a belated individual of the February generation, both at the beginning of April. The fact that the larvae were beginning to pupate in the middle of April would seem to indicate that there may be a partial second generation of the insect in the year.

The operations of the grubs damage the tree by removing the bast layer; but the small tunnels and chambers made by them in the sapwood to pupate are of no importance unless the insect is extremely numerous, when the entrance-holes would render the outer appearance of the logs unsightly and probably lead to their rejection by a timber contractor in the absence of definite knowledge that the tunnels do not penetrate into the heart-wood. They do not do so, and the insect does not therefore ruin the timber as is the case with the longicorn grub *Hoplocerambyx spinicornis*, which is found infesting the sál often in company with the buprestid and scolytid (*Sphaerotrypes*) in this locality.

The methods of protection described in detail later on under the *Hoplocerambyx* (p. 331) apply equally to this insect.

CAPNODIS.

Black or smoky-grey beetles with short antennae, a shield-shaped prothorax, and squarish shape.

Capnodis indica, Thoms.

REFERENCES.—Thoms. Guérin, *Rev. et Mag. Zool.* (3), vii, 176 (1878); *orientalis*, Thoms. teste Abeille, *Rev. d'Ent. Caen*, 270 (1896).

Habitat.—Almora, Punjab; Jaunsar, 2,000 ft. (below Kathian).

Trees Attacked.—Chir Pine (*Pinus longifolia*): Almora; Jaman (*Eugenia jambolana*): Jaunsar.

Description.

Beetle.—Elongate, black, with spots and patches of golden metallic colour studded with punctures on head, prothorax, and elytra. Prothorax with much-rounded sides, anterior edge emarginate, the posterior angles produced into points; deeply punctate, the punctured areas greyish; an irregular, central, raised, smooth, coppery area, with on each side two rounded, raised, smooth, coppery spots, first below upper margin, second contiguous with the lower margin half-way between outer angle and centre. Elytra elongate, with apex truncate and a number of greyish-coppery or black thickly punctured areas on surface. Length, 24 mm. to 26 mm.; breadth, 9.5 mm. to 10 mm.

Full-grown Larva.—Elongate cylindrical, whitish yellow, with a small head and twelve segments following it, which gradually taper posteriorly from the second. The prothoracic segment is of great width and size, and has a hard thick orange plate on its dorsal surface. Length, 62 mm.

Life History.

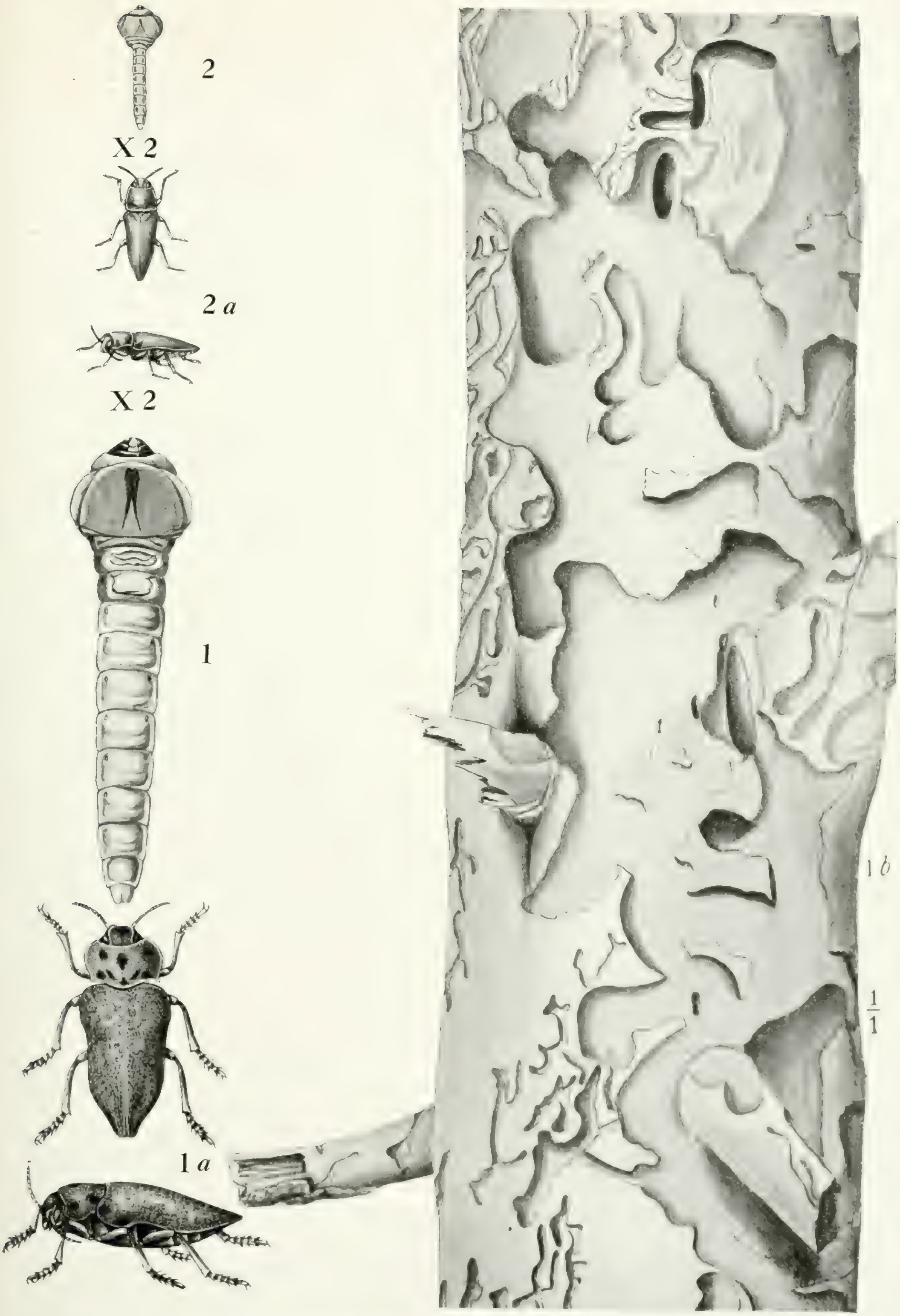
The beetle is usually to be found on the wing in Kumaun during July, August, and perhaps September. I took full-grown larvae of the insect in *Pinus longifolia* trees in the first week of June. They were just commencing to pupate. The eggs are laid in crevices in the bark of the trees during July and August. On hatching, the grubs tunnel down to the bast, and at first feed there, their tunnels soon, however, grooving the sapwood. These tunnels increase in size with the growth of the grub, and wind about in an irregular manner in the bast and sapwood, becoming very broad as the larva reaches full size, though remaining shallower than the tunnels of a longicorn grub of the same size. The tunnels are packed tightly with the wood-dust and excreta of the larva. When full-grown the grub carries its tunnel down into the sapwood, eats out there a pupal chamber parallel to the long axis of the tree, and pupates. When mature the beetle crawls up the entrance-tunnel, bites its way through the bark, and escapes from the tree.

A specimen in the Dehra Dun collections was taken from a jaman-tree some 2,000 ft. below Kathian in Jaunsar.

Damage Committed in the Forest.

Although the *Capnodis* is a comparatively common beetle in the Himalayan forest, I can find no mention of its attacks in the chir pine. Further observations are required on this head before its importance as a pest to the tree can be determined.

The remedial measures described for the buprestid pest of the deodar (*Sphenoptera*, p. 204) and the other one of the chir pine (*Anthaxia*, p. 212) would apply as well to this insect.



1. *Capnodis indica*, Thoms.—Larva and beetle. 2. *Anthaxia osmastoni*, Steb.—Larva and beetle.
1 *b*.—Section of stem of *Pinus longifolia*, showing the larval galleries of both beetles in the

Capnodis miliaris, Klug.

REFERENCES.—Klug. *Symb. Phys.* 15, pl. 2, fig. 1 (1821); Fairm. *Bull. S.E.B.* xxxv, 125 (1891). *daedalea*, Stevens, *Bull. S. N. Mosc.* 93, pl. 3, fig. 6 (1830); *albisparsa*, Falderman, ibid. 107; *miliaris*, Mars. *L'Abeille*, ii, 122 (1865); *metallica*, Ballion, *Bull. S. N. Mosc.* xlviii, 349 (1871).

Habitat.—Baluchistan: Quetta, Loralai, Fort Sandeman, Shinghar Hills, Ziarat; Kashmir. Also reported from Tripoli, Syria, Persia.

Trees Attacked.—Poplar (*Populus euphratica*): Quetta, etc.; ? Chenar (*Platanus orientalis*): Quetta; *Pinus Gerardiana* ?: Zhob.

Description.

Beetle.—Black or coppery-black; prothorax white or grey or coppery; elytra black, shining; under-surface black. Head rugose-punctate, bottom of punctures filled with a white squamose pubescence. Antennae black. Prothorax punctate, the bottoms of punctures filled with pubescence; an elongate, irregular, black, smooth, median raised area below anterior margin and not in contact with it; a rounded one medianly at base, its centre depressed into a deep pit just above the scutellum; four smaller rounded areas, two on each side, one below anterior margin and two contiguous with basal margin. Elytra with longitudinal punctate striae interrupted at sides by dull grey or coppery irregular rugose areas, these areas larger medianly and basally, smaller or mere rounded spots on upper half of elytra. Legs black. Length, 21 mm. to 39.5 mm.; breadth, 7 mm. to 18 mm. Baluchistan specimens varied greatly in size, the smallest taken being only 21 mm. in length.

FIG. 133. *Capnodis miliaris*, Klug. Baluchistan.

Larva.—Elongate, body segments tapering, the prothoracic segment greatly developed, with a longitudinal inverted V-shaped black marking on the median dorsal surface. Head and mandibles black; median abdominal segments longer than broad. Length, nearly 72 mm. (Fig. 30, *c*.)

Life History.

This beetle is common in Baluchistan. I have taken it in Quetta, Loralai, Fort Sandeman, Ziarat, and in the *Pinus gerardiana* forests in the Shinghar Hills. I have never, however, actually found it in this latter tree nor in the juniper forest at Ziarat. I found the beetle fairly plentiful in Quetta at the end of May, usually taking it resting in the large holes made in the poplar-trees by the *Aeolesthes sarta* (Quetta borer, see p. 307) longicorn pest. The buprestid doubtless made use of these places to leave the trees. The beetle was also plentiful in the pine forests round Shinghar (elevation 8,000 ft.) in North Zhob in June. In October of the same year (1905) the beetles were still to be found on the wing fairly plentifully in and around Quetta. It had been suspected that the grubs of this insect lived in the poplar and plane trees which form the fine avenues of the station, the former trees being plentiful throughout Baluchistan.

That the insect infests the *Populus euphratica* was proved by Mr. A. L. P. Tucker, C.I.E., at the time Agent to the Governor-General in Baluchistan. Mr. Tucker found the large larva shown in fig. 30, *c*, in one of the poplars in the Residency Gardens at Quetta, and subsequently we took a number of the grubs all nearly or quite full-grown. It would appear probable that the larvae mature at different periods throughout the spring, summer, and autumn months, the beetles thus issuing irregularly during this period. The

winter is passed in the larval tunnel in the tree either as a larva or pupa. The grub cuts out long, rather shallow, broad, irregular galleries in the bast and sapwood of the tree, thus destroying the cambium layer. The pupal stage and resting period of the beetle is from six weeks to two months.

It is perhaps still doubtful whether the insect lays its eggs (they are laid on the bark or at wounds on the tree) in the plane-tree, save sporadically when there are no poplars near. Owing to its abundance it is capable of proving a serious pest in a country like Baluchistan, where it is customary to grow the species of tree it infests in masses or clumps together.

The remedial measures given for the Quetta borer on p. 315 will serve equally to get rid of this pest.

Sub-family SPHENOPTERINAE.

Antennal pores concentrated in a terminal pit; posterior coxae nearly contiguous, dilated on outer edge, truncate exteriorly, their anterior margin nearly straight, posterior oblique; scutellum wide, most often acuminate behind; clypeus large, triangular; antennal cavities large, triangular, and terminal.

Only one genus of this sub-family is at present known in India. It contains, however, a very large number of species.

Sphenoptera.

Sphenoptera aterrima, sp. nov. Kerremans.

Habitat.—Simla Catchment Area Forests; Bashahr; Jaunsar; probably throughout Deodar Forests of Western Himalaya.

Tree Attacked.—Deodar (*Cedrus deodara*). Simla, Jaunsar, Himalaya.

The following is M. Kerremans' description of this species, which proves new to science:—

Sphenoptera aterrima, nov. sp.

Long. 11; larg. 4 mm.

Subovata, plana, antice posticeque attenuata, supra nigerrima, nitidissima, capite antice cuprescens; pronoto vix punctato; scutello transversim carinato; elytris parum costulatis, interstitiis alternatim elevatis, apice valde tridentatis; subtus nigro-aenea, nitidissima; prosterno profunde canaliculato, segmento primo sulcato

Ovalaire, peu convexe, atténué en avant et en arrière avec la dent externe des élytres saillante en dehors, d'un noir vernissé intense et très brillant en dessus; dessous plus clair, plus bronzé, tout aussi brillant; la partie antérieure du front cuivreuse.

Appartient au groupe des *Sphenoptera* ayant l'écusson caréné (*Tropeopeltis Jakwoh.*).

Tête assez fortement ponctuée, à points très rapprochés, transversalement impressionnée en avant; le vertex sillonné. Antennes courtes et grêles à troisième article plus long que le deuxième et plus court que le quatrième. Pronotum plus large que long, bisinué en avant et en arrière, arqué sur les côtés, sans strie marginale antérieures; la carène latérale sinueuse et entière; la surface très finement ponctuée, les points très espacés. Écusson caréné transversalement. Élytres peu convexes, sinués sur les côtés avec la dent externe saillante en dehors; le calus huméral saillant et lisse; la surface finement et inégalement ponctuée à stries fines et peu profondes; les interstries alternativement saillants et aplanis, ces derniers plus larges que les autres. Dessous finement pointillé; prosternum profondément canaliculé; milieu du premier segment abdominal sillonné, côtés des segments abdominaux impressionnés, sans reliefs lisses. Pattes médiocres; les tarses postérieurs grêles et aussi longs que les tibias.

Hab.—Simla (Stebbing).

Plate xv, fig. 2, shows this beetle. The following are my descriptions of the larva and pupa :—

Young Larva.—A tiny white grub with a greatly enlarged prothoracic segment. The head small and yellow. The body segments much narrower than the thoracic segment (fig. 134, *a*).

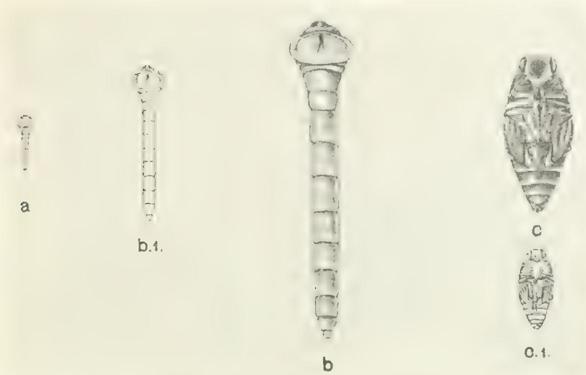


FIG. 134.—Larva and pupa of *Sphenoptera aterrima*, Kerremans. *a*, young larva ; *b*, natural size and enlarged ; *c*, pupa natural size and enlarged. N.W. Himalaya.

Full-grown Larva.—The larva is yellowish, flat, elongate, and narrow, with a large prothoracic segment immediately following the small yellow head ; the segments succeeding this large prothoracic segment are very much narrower in width, and are more or less equal to one another in size, save the last two, which taper Its length is about an inch and a quarter, and it is usually found in its gallery with its lower segments curved round so as to lie against the ones above them. Fig. *b*1, *b*, show the larva natural size and enlarged.

Pupa.—Elongate-ovate, yellowish in colour. More ovate than the beetle, which it generally resembles ; the antennae, legs, and wings are pressed against the chest. Fig. *c*1, *c*, show the pupa natural size and enlarged.

Life History.

The egg is laid by the female in June either on the bark or down on the inner surface of the bast, since the young larval gallery appears to commence here. The grub feeds in the bast, at first eating out irregular chambers as shown in fig. 135 ; as it gets larger it goes deeper and grooves both the outer bark and the sapwood. This gallery has no definite direction. Sometimes it is carried up the tree, at others down or across, especially when the larva is young (see pl. xiii). It curves about, the total length being from two to two and a half inches, and the breadth at its widest part about a sixth to a quarter of an inch. When the grub is full-grown it bores down into the sapwood at an angle for about half an inch, and then eats out a pupal chamber in the wood somewhat larger than the size of the future beetle ; the section of the entrance-tunnel in the wood is narrow elliptical, and the presence of these entrance-tunnels in the sapwood is very characteristic of the beetle, and they are clearly visible when the decayed bark above has fallen off in patches. The larva changes to a pupa in the pupal chamber, and the beetle on maturing crawls out of the tunnel, eats its way through the bark if it has not fallen off already, and escapes from the tree. A characteristic feature of this attack is shown in pl. xiv. The bark covering the larval galleries beneath

FIG. 135. — Galleries of young larva of *Sphenoptera aterrima* in bast of deodar. N.W. Himalaya.

apparently rapidly decays and falls off, or more often is pecked off by woodpeckers to get at the grubs beneath, and thus an attacked tree shows at the spots infested irregular-shaped areas of the whitish-yellow sapwood. This feature is very often present in the case of saplings and young poles, and enables attacked trees to be readily recognized.

For some years past the larva of this beetle has been known to infest deodar. I took it in deodar-trees in Bashahr towards the end of June 1901, in newly felled trees at Pajidhar in the third week in June in 1902 (the grubs being from a day or two to a fortnight old only), and again in November 1906 in the tops of converted green trees felled in that year near Konain in Jaunsar.

In 1908 a bark-beetle attack started in the Simla Water Supply Catchment Area, and investigation showed that this insect was also present.

During the years 1908–9 it was proved, with the help of Mr. V. Munro and Pandit Gokal Dass, that this *Sphenoptera* passes through only one generation in the year. The mature beetles leave the trees during June, pair, and the female lays her eggs in the bark of any newly felled unbarked trees she can find or in standing sickly trees, in snow breaks and wind-thrown trees.

The young larvae hatch out from the egg in about a week, and at once eat their way down to the bast and gnaw out little irregular-shaped patches in the latter (fig. 135). The grubs on increasing in size go down deeper and groove both the bast and sapwood. It is probable that in some cases the grubs become full-fed in the autumn, and change into pupae in late October or November in the small pupal chambers eaten down into the sapwood by the grubs. The winter is then passed through here either as a pupa or immature beetle.

Probably many of the grubs who pass the winter in the bast owing to their not having attained full growth, and consequently not having tunnelled down into the sapwood to prepare the pupal chamber, perish in severe cold winters.

This is not the case in open dry ones, as was proved in the Simla Catchment Area in 1908, when immature living grubs were found in the trees at the beginning of April.

Damage Committed in the Forest.

The damage committed by this insect when numerous in a forest is very serious. The young larvae require absolutely fresh green bast, and therefore the eggs are very often laid in green, and apparently green standing, trees.

The irregular method of feeding of the grubs renders the insect more destructive than would ordinarily be the case, as they girdle a tree much more rapidly, even when but a moderate number of insects are present, than is ordinarily the case with bark-borers. Instances have been seen where trees attacked at the base only have been ringed by a comparatively few larvae and so killed. Within the limits defined by their several life histories, bark-borers of the *Scolytus* type go into a tree anywhere, and thus require to be unusually abundant before their operations ring and kill a tree.

PLATE XIII.

Larval galleries with living larvae *in situ* of *Sphenoptera aterrima*, Kerrem., on the inner surface of the bark of the deodar (*Cedrus deodara*). Simla Catchment Area Forests, North-West Himalaya.

The buprestid attacks trees of all sizes, but it was perhaps found to be most abundant in the Simla Catchment Area in snow-bent and broken green saplings, of which there were a number in the forest.

A characteristic of this insect appears to be that it always attacks the trees on the sunny side, i.e. the southern ; if the tree is bent over, as in the case of snow-breaks, it invariably attacks it on the upper side. This is in exact opposition to the habits of the bark-boring insects, which usually attack on the northern or, in the case of bent or felled trees, on the under side. This habit renders the two pests, when working together as they were in the Simla Catchment Area in 1908, more deadly, as they kill the trees quicker.

Protection and Remedies.

The methods of dealing with the deodar bark-borer (*Scolytus*) beetle when it has appeared in a forest in considerable numbers, or of ascertaining whether it is in the forest in any numbers, are fully explained on page 572. These methods may be introduced to combat the attacks of the deodar buprestid beetle.

It will often be found that the scolytid and buprestid are present in the tree together, and the barking of the tree and burning of the bark carried out to get rid of the scolytid will equally kill off the buprestid grubs provided it is done between the months of July and October. If done earlier you may not catch all your buprestid larvae, since the beetles will not have finished egg-laying. If done later than October merely barking the tree will not suffice, since many of the grubs will have already tunnelled down into the sapwood and will be safe in their pupal chambers. Taking off the bark and burning it will not be sufficient then. It would be necessary to burn the whole infected tree.

Ephialtes viridipennis, sp. nov., Morley. *Faun. Br. Ind.* Hymenop. Ichneumenidae.

Parasitic Foes.

Fly.—Elongate, black, with long antennae and two pairs of iridescent veined wings and elongate legs. Body elongate and curved downwards. In fig. 137, *b*, *b*1, show the fly enlarged twice and natural size, and *c* a side view of the fly enlarged twice.

Larva.—Elongate, white, the thoracic segments having the greatest diameter, the prothoracic segment being constricted anteriorly. The six median abdominal segments furnished with a circular ring of four swollen tubercles situated medianly, dorsally, ventrally, and laterally ; the remaining segments taper posteriorly. In fig. 136, *a*, *a*1, show the larva enlarged twice and natural size.

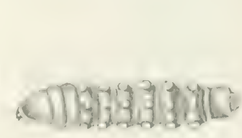


Fig. 136.—Larva of *Ephialtes viridipennis*, Morley. *a*, Enlarged.

Life History.—It was noticed in August 1908 that small elongate hymenopterous grubs were present in some of the young buprestid galleries in

the deodar-trees. These grubs were feeding parasitically on the buprestid grubs. In pl. xiii a few of these long white grubs pointed at both ends are to be seen in the buprestid galleries.

When full-fed (some time in the autumn) the parasitic grub spins a flat elliptical paper-like cocoon and pupates within this, as shown in the figure. The winter is passed in this stage, cocoons having been taken in April.

FIG. 137.—*Ephialtes viridipennis*, Morley. Fly natural size and enlarged. N.W. Himalaya.

The fly on maturing eats through from the papery cocoon and the bark and escapes. It issues at the same time as the buprestid beetles emerge, and evidently lays its eggs near those of the buprestid beetle, probably depositing them singly in crevices close to those of the *Sphenoptera*.

This insect is of course a valuable ally to the forester, and its appearance both in the grub and imago stage should be known to the Forest Officer.

Hymenopterous Fly.—In April 1908 small silky cocoons of what is a second hymenopterous parasite of this buprestid were taken. These were far smaller than those of the insect above described, and were found as many as five together placed side by side in the one pupal chamber of the buprestid. Each cocoon contained a small partially developed hymenopterous fly which I was unable to rear. The fly is small, blackish, with transparent iridescent wings.

Woodpeckers (*Dendrocopus himalayensis*, Harjitt; and *Gecinus squamatus*, Blyth).—The common hill woodpeckers, the pied woodpecker (*Dendrocopus himalayensis*) and the scaly-bellied green woodpecker (*Gecinus squamatus*), and doubtless other species, feed with avidity on the grubs of this buprestid beetle, pecking off the bark in little round or elongate patches as shown in pl. xiv, to get at the grubs in their galleries beneath. The yellow sapwood exposed in this manner all up the length of one side of a standing tree or along the uppermost part of the bark of a felled or fallen tree is easily visible, and is most characteristic of the attack of this beetle and of its presence in the forest.

Portion of a deodar (*Cedrus deodara*) pole showing patches of bark removed by woodpeckers to get at the grubs and pupae of *Sphenoptera aterrima*, Kerrem. Simla Catchment Area, North-West Himalaya.

Sphenoptera la fertii, Thomson.

REFERENCE.—Thoms. *Typ. Bupr.* 65 (1878).

Habitat.—Chamba, North-West Himalaya. Also reported from North-West Himalaya, Moradabad.

Tree Attacked.—Deodar (*Cedrus deodara*). Kalatope, Chamba.

Beetle.—Elongate, constricted at apex. Blackish bronze; head and thorax with a coppery punctation. Under-surface brilliant coppery, middle of sternal region metallic green; legs coppery; antennae and tarsi black. Head flat, punctate. Prothorax with a smooth, sinuate, lateral carina and a very short longitudinal furrow on disk; irregularly and densely punctate, bottom of punctures coppery. Elytra three and a quarter times as long as thorax, widened at extremities owing to the outermost spine projecting outwards; median spine wide, its tip incurved towards the suture, sutural spine very short and sharp; deeply striate-punctate, the intervals between striae finely pitted and raised, resembling costae, of which three are more prominent towards apex, being projected into the spines. Under-surface and legs rugose-punctate; the two first abdominal segments with a wide median channel; anterior and median tibiae strongly recurved in male, nearly straight in female. Length, 10 mm.; breadth, 3.25 mm.

Description.

Life History.

I took an individual of this species on the bark of a large standing green deodar-tree at Kalatope, Chamba, on 24 May 1909. It is possible that the species infests the tree in company with *S. aterrima*. It is far less common, however, so far as present observations go.

Sphenoptera cupriventris, Kerremans.

REFERENCE.—Kerrem. *C. r. Soc. Ent. Belg.* xxxiv, 203 (1890).

Habitat.—Kanara and Belgaum; Bengal, Konbir, Mandar, Barway (P. Cardon).

Trees Attacked.—*Anogeissus latifolia*: Bengal. Taken in trees (spp. ?) in felling areas in Kanara and Belgaum (Andrewes).

Beetle.—Very convex above, flat beneath. A dull bronze, with violet or coppery reflexions; brilliant coppery beneath, the sternal region greenish, sides of abdomen violet; antennae and tarsi black. Head bituberculate between the eyes, slightly channelled on vertex. Prothorax finely and irregularly punctate; punctures densest on sides. Elytra very convex, the humeral calus smooth and prominent; weakly punctate-striate; an elevate, slightly curved costa on apical third of elytra, whose prolongation forms the median spine, which is large and broad, the lateral one not being prominent and the sutural one scarcely visible. Abdominal segment channelled medianly. Length, 13 mm. to 15 mm.; breadth, 2.5 mm. to 4.5 mm.

Description.

Larva.—Yellowish white, with stout black mandibles. Prothoracic segment broader than any of the segments behind it.

Life History.

I have taken this insect infesting *Anogeissus latifolia* in Bengal, and Mr. Andrewes has reported that it is very common in Belgaum and Kanara, where it is often taken in areas felled over the preceding year in which the felled trees are still lying. No mention is made of the species of tree in which he found it.

The beetle appears on the wing about April or May, or even as late as June, and lays her eggs on the bark of newly felled trees, or in the thick portions of the tops of the trees felled during the latter part of the cold weather, or in standing sickly trees. The grubs feed in the bast, eating out rather broad, shallow, and very winding galleries in the bast and sapwood. When full-fed they eat out small elliptical pupating-chambers, usually in the sapwood, but in the case of old, thick, hard-barked trees, the pupating-chamber may be in the bark. The larva changes to a pupa in this chamber. I have not yet ascertained how long is spent in the larval stage by this grub, nor whether the beetle passes through two generations in the year.

Sphenoptera indica, Cast. et Gory.

REFERENCE.—Cast. et Gory, *Mon. Bupr.* ii, 37, pl. 10, fig. 57 (1839).

Habitat.—Dehra Dun, Northern India. Also reported from Belgaum (Andrewes); Kanara (Bell); Barway, Mandar, Konbir, Tetra (P. Cardon); Pegu.

Tree Attacked.—*Indigofera pulchella.* Dehra Dun.

Description.

Beetle.—Elongate, cuneiform. Brilliant bronze, lighter on thorax than on elytra; latter somewhat dull at tips; under-surface brilliant purple mingled with blue and green, especially on abdominal segments; antennae and tarsi black. Head punctate-rugose, vertex channelled. Prothorax nearly square, scarcely as wide as long, irregularly punctate, punctures denser and more regular laterally; disk with a median longitudinal channel. Elytra nearly three times length of thorax, constricted regularly to apex; latter slightly spined and slightly channelled along suture; a longitudinal series of punctures. Under-surface rugose-punctate. Length, 10 mm. to 12 mm.; breadth, 3 mm. to 3.5 mm.

I took a specimen of this buprestid on *Indigofera pulchella* at Jhajera, in the Dehra Dun, on 6 January 1907. I know nothing further about the beetle.

Sub-family BUPRESTINAE.

Antennal pores concentrated in a pit on each joint, the pit being situated either at the bottom or top of the joint; antennal cavities variable; scutellem variable; posterior coxae distinctly dilated on the inner side.

The sub-family is divided into three divisions, all containing representatives of forest importance:

1. *Dicerites.*—Eyes oblique; antennal pores in pits placed at base of joints; metasternal epimera completely exposed. (*Lampra.*)

2. *Buprestites.*—Differs from *Dicerites* in having eyes parallel. (*Buprestis* (*Ancylocheira*).)

3. *Anthaxites.*—Antennal pores in pits placed at top of joints. Metasternal epimera partly covered by the lateral prolongation of the abdomen. (*Anthaxia.*)

LAMPRA.

A new species of this genus was taken on young india-rubber plants in Assam.

Lampra assamensis, sp. nov., Stebbing.

Habitat.—Darrang, Assam.

Tree Attacked.—*Ficus elastica.* Charduar Rubber Plantation, Darrang, Assam.

Description.

Beetle.—Elongate, constricted behind, with brilliant metallic colouring. Head purple in centre, metallic blue-green on either side. Disk of thorax purple, with a longitudinal median area green, the lateral margins green anteriorly, the basal half crimson. Scutellum light blue-green. Elytra with basal margins green, merging into dull coppery medianly, this latter colour produced in a longitudinal median dull band to apex, a broad, crimson, longitudinal band laterally ending in the apical fourth, the band interrupted by purple patches. A yellow coppery spot immediately behind the band, apical fourth coppery-purple. Head strongly rugose-punctate, with a frontal median depression and a weak longitudinal line basally on vertex. Prothorax much wider than long, anterior margin weakly sinuate, sides rounded, base bisinuate, median lobe produced; rather finely rugose-punctate, coarsely so laterally, the purple areas on disk sparsely punctate. Elytra slightly wider than thorax at base, sides sinuous at level of posterior coxae, thence constricted sharply to apex, the edges, in slightly over apical half, toothed; apices separately rounded and toothed; striate-punctate, the striae most prominent on apical sutural two-thirds; the punctures fine, densest laterally. Under-surface brilliant coppery-green. Abdominal segments crimson. Length, 9.5 mm.; breadth, 3.1 mm. The species is figured in pl. xv, fig. 3.

Life History.

I took a specimen of this brilliantly-coloured buprestid in April 1906 on a leaf of one of the young eight-foot sapling plants in the rubber nursery at Charduar in Assam. When disturbed the beetle feigned death, and dropped to the ground. The insect proves new to science.

BUPRESTIS.

Buprestis (Ancylocheira) geometrica, Cast. et Gory.

REFERENCES.—Cast. et Gory, *Mon. Bupr.* i, 141, pl. 35, fig. 194 (1837); *decemnotata*, Cast. et Gory, id. 133, pl. 33, fig. 184; *aurantiopicta*, Cast. et Gory, id. fig. 183 (next text).

Habitat.—Ravi Valley, Chamba, North-West Himalaya. Also reported from Simla, Himalaya, Bengal.

Tree Attacked.—*Pinus longifolia.* Chamba, Ravi Valley.

Description.

Beetle.—Elongate, finely granulose. Dull bronze or black, with yellow or yellowish-red spots on elytra; under-surface and legs coppery-bronze. Head broad, finely punctate, front yellow, with two small black spots placed one on each side of a middle line, a small depression on vertex placed medianly behind the yellow patch. Prothorax broader than long, punctate, with here and there small smooth areas; a yellow spot at lateral edges and on lateral halves of anterior margin. Elytra slightly wider than thorax at base, constricted in upper fourth and truncate, the extremities weakly sinuate; striate-punctate, with four largish orange patches placed on external half of each elytron, the upper one near the humeral angle and coming down on to the lateral edge, the basal irregularly triangular, not reaching apex, the other two between these at

equal distances. Under-surface finely punctate, with patches of yellow on the head and thorax, and a spot placed laterally on the terminal segment. Length, 17 mm. to 18 mm.; breadth, 6 mm. to 6.5 mm.

I took a specimen of this beetle on the bark of a *Pinus longifolia* in the Ravi Valley of the Chamba State, North-West Himalaya. I know nothing further on the subject of its life history.

Buprestis kashmirensis, Fairmaire.

Habitat.—Kalatope, Chamba, North-West Himalaya.

Tree Attacked.—? Oak (*Quercus incana*).

Description.

Beetle.—Brilliant green, the elytra with a number of prominent longitudinal carinae smooth and darker green than the rest. Head wide, the front studded with an irregular network of raised prominences. Antennae short, toothed from fifth joint. Eyes large, prominent-elliptical, brown in colour. Prothorax wider than long, narrower in front than behind. A median longitudinal channel not reaching to base; disk punctate, almost reticulate, the punctures and reticulations coarser laterally, where there is a median depression near the margin. Scutellum bright coppery, the centre deeply impressed and golden green. Elytra incurved and impressed behind the shoulder, constricted behind, apex truncate with two small teeth. Six longitudinal and very prominent carinae on each elytra, the sutural and marginal ones the least prominent, the fourth from the suture reaching only half-way down the elytra, second and third joining to form the outer tooth; the spaces between the carinae set with a coarse granulation. Under-surface coppery with a green sheen, punctate; the first abdominal segment with a broad longitudinal furrow medianly. Length, 22 mm.; width, 8.2 mm.

Pl. xv, fig. 4, shows this beetle.

I took a specimen of this beetle on an oak-tree in the Kalatope Forest in Chamba on 23 May 1909. This insect has but recently been described. Only three specimens are known to Kerremans, who states it to be very rare.

Anthaxia.

The two species of this genus I have taken in trees prove new to science.

Anthaxia osmastoni, sp. nov., Stebbing.

Reference.—Stebbing, *Ind. For. Mem. Zool. Ser.* vol. ii, pt. ii, p. 80 (1911).

Habitat.—Kumaun, Western Himalaya.

Tree Attacked.—*Pinus longifolia.* Bellek, etc., Kumaun.

Description.

Beetle.—Front of head golden green, vertex golden. Prothorax golden green, disk golden with a coppery reflexion. Elytra darker greenish blue with a blue reflexion, the apical portion darkest. Under-surface golden with greenish reflexions. Front of head flat, finely reticulate, the reticulations on vertex very fine. Prothorax broad, sub-quadrangular, depressed laterally on either side in basal half; anterior margin sinuate, sides rounded; surface reticulate, more strongly so on lateral portions. Scutellum heart-shaped. Elytra flat, except near base, where they are irregularly elevate above a transverse basal depression; sinuate at level of posterior coxae, sharply constricted behind, very finely toothed in apical fourth; apices separately rounded; surface uniformly and finely rugulose-granulose. Length, 7.2 mm.; breadth, 2.2 mm. The beetle is figured in pl. xv, fig. 5.

PLATE XV.

Fig. 1. *Acmaeodera kerremansi*, sp. nov., Stebbing.

„ 2. *Sphenoptera aterrima*, sp. nov., Kerremans.

„ 3. *Lampra assamensis*, sp. nov., Stebbing.

„ 4. *Buprestis kashmirensis*, Fairmaire.

„ 5. *Anthaxia osmastoni*, sp. nov., Stebbing.

„ 6. *Anthaxia marshalli*, sp. nov., Stebbing.

„ 7. *Agrilus salweenensis*, sp. nov., Stebbing.

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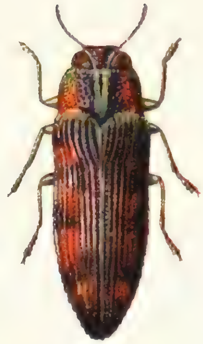

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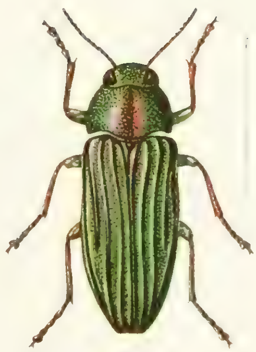

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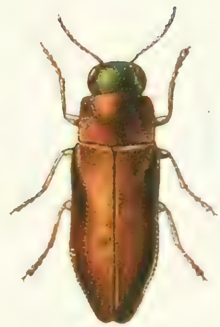

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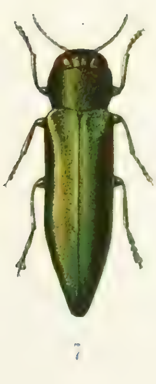

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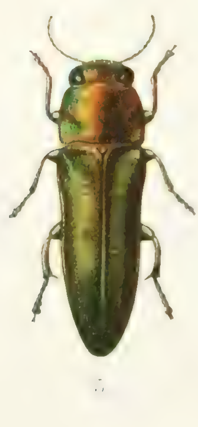

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Larva.—Short, elongate, with a small brownish-yellow head, black mandibles, and a large, flat, spherical segment following the head. The segments behind the large one are all very much smaller in diameter and of approximately the same size save the last, which tapers posteriorly. Length, ½ in. (see fig. 2 in pl. xii).

The shape of the larva is most characteristic, and renders it easily distinguishable from the longicorn pest (*Nothorrhina*, *vide* p. 281) with which it is occasionally found in the tree.

Little appears to be known upon the life history of this small buprestid.

Life History. Grubs of various sizes were taken by myself in the bast layer of chir-trees in the middle of October in Jaunsar in 1906, and it is probable that these grubs hibernate in this position in their larval galleries and pupate some time during the spring. The perfect beetle was found mature and issuing from the trees, or ready to issue, at the end of May (in Kumaun in 1908).

Thus it appears probable that the life-cycle takes a year to pass through from egg to perfect beetle, as is the case with the small deodar buprestid described above.

The egg is probably laid by the beetle in crevices in the bark of the tree some time in June. The grub, on hatching out, at once tunnels down into the bast layer and feeds in this, at first eating out a small gallery of irregular shape; as it grows larger the gallery increases in size and goes down into the deep bast, and also grooves the sapwood (the smaller galleries in fig. 1, *b*, pl. xii). When full-fed the grub bores a short elliptical tunnel down into the sapwood, and then eats out an elongate pupating-chamber parallel to the long axis of the tree (top of fig. 1, *c*).

The larval gallery in the bast is blocked with excreta and wood-dust, but that in the sapwood is free of both. The beetle, on maturing, crawls up this empty larval tunnel, and, on reaching the bast, bores its way through it and the bark and escapes from the tree.

Anthaxia marshalli, sp. nov., Stebbing.

Habitat.—Changa Manga, Punjab.

Tree Attacked.—Sissu (*Dalbergia sissoo*). Changa Manga Plantation, Punjab.

Description. Small, oblong, slightly convex. Head flat, coppery-green; prothorax and elytra brilliant coppery; under-surface coppery-green. Head very finely reticulate. Prothorax wide, subquadrangular; anterior margin sinuate, sides but slightly rounded; finely reticulate and with very fine granulations, reticulations coarser laterally and posteriorly; a prominent triangular depression in lateral posterior half. Scutellum triangular. Elytra rather sharply sinuate at posterior coxae, constricted apically, finely toothed in apical half, apices separately rounded with a small sutural angle; surface finely rugulose-granulose. Under-surface finely reticulate. Length, 5.75 mm.; width, 1.5 mm. Fig. 6 in pl. xv. shows the insect.

I cut out a dead specimen of this buprestid from its pupating-chamber in the wood of a dying sissu-tree in the Changa Manga Plantation on 17 May 1905. The insect is new to science, and I take pleasure in naming it after that eminent entomologist, Mr. Guy A. K. Marshall. The grub eats out an elongate winding gallery entirely in the cambium layer, only boring into the sapwood to pupate.

Sub-family CHRYSOBOTHRINAE.

Front of head constricted at insertion of antennae; antennae bent, third joint very elongate; poriferous pits variable; eyes oblique, placed close together on vertex.

This sub-family contains the large genus *Chrysobothris*, of which there are a considerable number of Indian species. The sub-family contains two species known to infest forest trees. It is probable that a number of the other known species will be found to oviposit in trees.

CHRYSOBOTHRIS.

A large genus with numerous species in India, some of which may prove to be of importance in the forest. The elytra often have circular depressions on them of a different colour from the rest of the surface.

Chrysobothris musae, Théry.

REFERENCE.—Théry, *Ann. Soc. Ent. Belg.* xlviii, 160 (1904).

Habitat.—Ceylon.

Tree Attacked.—? Plantain (*Musa sapientum*). Hovonapotani, Ceylon.

Beetle.—Oblong-oval, sub-parallel, but slightly convex. Front of head dull red, brilliant behind the eyes and on vertex; prothorax bluish black, edged anteriorly with red; elytra olive-green, with four lighter-coloured impressions; under-surface green medianly; posterior tibiae and tarsi blue. The prothorax is furrowed behind the anterior margin, the latter nearly straight, anterior angles acute, sides sinuate in middle, posterior angles rounded, base bisinuate, the median lobe slightly truncate. Scutellum small. Elytra with the four impressions arranged as follows: (1) on the basal lobe; (2) smaller, behind the humeral calus; (3) in centre of disk; (4) placed nearer the margin in the apical fourth; a raised costa parallel to suture, a second meeting first at base and ending in apical fourth. Length, 10 mm.; breadth, 4 mm.

Description.

This beetle has been reported as taken on plantain-trees in Ceylon.

Chrysobothris indica, Cast. et Gory.

REFERENCE.—Cast. et Gory, *Mon. Bupr.* ii, 12, pl. 3, fig. 17 (1838).

Habitat.—Kowloon Island, Salween River, Tenasserim; Andaman Islands.

Tree Attacked.—*Terminalia tomentosa* (Kowloon Island, Salween River).

FIG. 138.—Larva of *Chrysobothris indica.* Tenasserim.

FIG. 139. *Chrysobothris indica*, Cast. et Gory. Tenasserim.

Description.

Beetle.—Slightly dull coppery-bronze. Three highly punctate coppery-red or yellow depressions on each elytron. Under-surface brilliant green; legs, sides, and last abdominal segment coppery. Head with a well-marked transverse carina between the eyes. Sides of prothorax concave just above the middle, anterior and posterior angles oblique, anterior margin slightly sinuous, median lobes slightly produced, base bisinuate, with median lobe much produced, as are posterior angles. Elytra with apical portions separately rounded, a longitudinal depression at shoulder, and a well-marked costa running parallel to suture in apical half, a less well-marked one parallel to constricted edge in apical third, meeting the sutural one at apex, and a third, broken, in the angle between these two; the three circular depressions are placed longitudinally and medianly on each elytron: (1) just above base, (2) in basal half, (3) in lower part of apical third. Last abdominal segment carinate down middle, and furnished with two terminal sharp spines; anterior femora unidentate. Length, 12.5 mm.; breadth, 5 mm.

Life History.

The beetle appears on the wing in Tenasserim some time during December or January, and lays its eggs in crevices in the bark of green sickly *Terminalia tomentosa* trees or in newly felled ones. The larva, on hatching out, feeds upon the bast layer at first, and then goes into the sapwood, remaining in the outer layers, where it eats out a flat, winding, shallow gallery in the wood. This gallery is packed with the wood-dust and excreta of the feeding grub. The larval gallery varies greatly in direction; it is usually carried more or less parallel to the long axis of the tree, but it may bend to right or left for no apparent cause. From the appearance and size of the gallery it would appear that the larva increases rapidly in size after first hatching out, and more slowly at later stages. The larval gallery shown in fig. 140 is almost seven inches in a straight line from end to end without the curves. The larva, when full-grown, eats out a pupal chamber by boring down into the wood at a sharp angle, the chamber so eaten out being about an inch in length (cf. fig. 140), rather broad, and oval in shape. This chamber is quite free from the wood excreta and dust with which

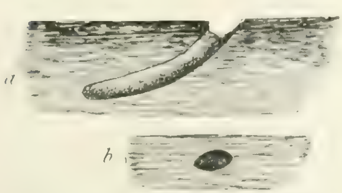


FIG. 140.—*a*, Pupal chamber in sapwood; *b*, cross-section of larval tunnel in wood. (E. P. S.)

FIG. 141. Larval gallery in bast and sapwood.

the larval gallery is filled; the diameter of the tunnel is a quarter of an inch. The beetle, on maturing, crawls up out of the pupal chamber (the larva turning round in the pupal chamber so as to face upwards, as is usually the case with these wood-pupating grubs), bores its way out through the bark above, and escapes from the tree.

In the sapwood of a large *Terminalia* tree which had been felled some time in September or October the preceding year I took a number of dead beetles *in situ* in their pupal chambers; also a few fully-grown larvae. An examination of the tree showed that the main bole had been attacked from top to bottom by this insect, the major part of the bast having been removed by the grubs. Most of them had matured and left the tree either in December or January, the beetles found in the first week in March being quite fresh, and, though dead, not yet dried and desiccated. The larvae found were taken on 9 March, and were either very belated ones, or had resulted from fresh eggs laid in the tree near the base of the butt (where the sapwood was still moist) by the December or January generation of beetles which had matured in the tree. The fact that a generation of the beetles issues in the cold weather appears to render it certain that the insect passes through at least two life-cycles in the year, and there may be more than two.

Damage Committed in the Forest.

From the data on its life history already known this small buprestid must be looked upon as one of the dangerous forest pests. We do not yet know what trees, other than the *Terminalia*, it infests, but it will probably be found to have several hosts. It is a hardy insect, and capable of increasing rapidly in considerable numbers when circumstances are favourable to it. Its life history consequently requires to be understood.

Chrysobothris sexnotata, Gory.

REFERENCES.—Gory, *Mon. Bupr.* Suppl. iv, 159, t. 27, fig. 154 (1841); Thompson, *Rep. Ins. Destr. to Woods and For.* p. 12 (1868).

Habitat.—United Provinces Sál Forests. Also reported from Malda (Bengal); Andaman Islands; Hong Kong; Java; China.

FIG. 142. *Chrysobothris sexnotata*, Gory. United Provinces.

Tree Attacked.—Sál (*Shorea robusta*). United Provinces.

Description.

Beetle.—Resembles *indica*. A green-bronze with violet reflexions, the latter most visible on the elytra; posterior margin of head brilliant blue-green; prothorax with the posterior angles a bright golden-red; three bright green depressions on the elytra; under-surface of head and body and the legs coppery at sides, green in the middle. Head with the transverse carina between the eyes more arched than in *indica*, and distinctly pubescent; front rugose in appearance. Prothorax with a deep and rather dense punctation, the small transverse ridges more regular and parallel than in *indica*. Elytra regularly punctate, the three green depressions as in *indica;* costae shorter and less well-defined, the sutural one most prominent. Under-surface punctate. Length, 10 to 13.5 mm.; breadth, 4.5 mm. to 5 mm.

Life History. The life history of this insect is at present imperfectly known. The beetle appears on the wing towards the end of the hot weather and commencement of the monsoon season, the grubs pupating either just before winter or in March. The grub feeds in the bast layer (the eggs being laid in crevices in the outer bark), eating out here irregularly winding galleries. When full-fed the grub tunnels down into the sapwood, eating out an elongate tunnel more or less parallel to the long axis, as shown in fig. 140.

Thompson, in alluding to this beetle, says: "A very pretty buprestid was found by me in felled logs in the Kotree Dhoon. The larva, after acquiring maturity, bores into the timber to the depth of from two to three inches, making a diamond-shaped orifice. It then undergoes its metamorphosis in the pupa state. These beetles sometimes infest trees in vast numbers, rendering the timber unfit for use afterwards."

I found numerous evidences of the presence of this insect in the Horai Forest (Kumaun) about the middle of May 1908. In some fallen dead sál-trees examined, both boles and branches had been riddled by this beetle, most of the bast layer having been removed, whilst the entrance-holes leading down into the pupal chambers were very numerous in the wood (cf. fig. 128).

The number of life-cycles passed through in the year is unknown.

Belionota.

Belionota prasina, Thunberg.

(The Mango Buprestid.)

References.—Thunberg, *Nov. Spe. Ins.* v, 90 (1789); *pyrotis*, Illiger, *Wiedem. Arch. Naturg.* i, 119, pl. 1, fig. 3 (1800); *scutellaris*, Weber, *Obs. Ent.* 72 (1801); *prasina*, Kerrem. *Ann. Soc. Ent. Belg.* xxxvii, 235 (1893).

Habitat.—Chicacole, Ganjam, Madras. Also reported from Bengal; Kurseong; Kanara (Bell); Ceylon, Senegal; Zanzibar (Maurice); La Réunion; Java; Sumatra.

Tree Attacked—Mango (*Mangifera indica*). Chicacole, Ganjam.

Description. **Beetle.**—Oblong, elongate. Head bronze, with a median line on vertex, and edges of latter bright green, the lateral stripes stretching down on to front. Prothorax olive-green with a coppery reflexion, posterior outer angles brilliant crimson or red; elytra dark green, with at times a coppery or blue reflexion; under-surface shining-green, with the sides dull bronze. Antennae dull bronzy-black; legs coppery-green. Head very finely and irregularly punctate. Prothorax punctate, punctures denser on sides. Scutellum large, finely punctate, acuminate behind. Elytra rounded at shoulder, constricted from posterior coxae on a regular curve to apex, the suture produced into a fine spine; four prominent, but not broad, longitudinal costae, the second and third meeting two-thirds up elytra. Length, 20 mm. to 29 mm.; breadth, 7.25 mm. to 10.5 mm.

Fig. 143. *Belionota prasina*, Thunberg. Ganjam, Madras.

Life History. As fully described under the longicorns *Plocæderus obesus* (p. 295) and *Batocera titana* (p. 367), mango-trees in gardens at Chicacole, in the Ganjam district of Madras, were reported by Mr. Cox, I.F.S., in March 1907 as very seriously infested by beetle-grubs. As the result of careful observations by Messrs. Cox and T. Reilly, I.C.S., the Sub-District Officer, it was discovered that more than one kind of grub was present infesting the trees. Specimens of grubs forwarded enabled me to state definitely that the grubs were buprestid and longicorn ones. At various intervals, sections of infested mango logs were sent to me at Dehra, and placed in a breeding-cage with the object of procuring beetles from them, and thus ascertaining the authors of the damage being done. The investigations carried out met with complete success. From a log sent from Chicacole on 18 December 1908, specimens of the buprestid *Belionota prasina* issued in the breeding-cage at Dehra on 23 April 1909.

The life history evidently takes a year to pass through in comparatively cold climates such as Dehra. Whether this is the case in Ganjam has yet to be ascertained. With Mr. Cox's first consignment of grubs taken early in March, he sent some buprestid grubs which were probably those of the *Belionota*. The grubs were small, and may have recently hatched from the eggs laid by the beetles towards the end of February. This would mean that the beetle appears on the wing towards the end of February in Ganjam. If this is the case, it may pass through two generations in the year in that locality.

The grubs confine themselves entirely to the bast and sapwood, eating out winding, shallow, rather broad galleries in this. They only penetrate deeper into the sapwood to pupate. The damage done is to the bast layer of the tree, and when they accompany the longicorn grubs it will be readily evident that the injury done to the trees is very serious.

Since the beetle has a wide distribution, it is possible that it may infest other trees besides the mango. Methods of dealing with it and its companions are described on p. 370.

Sub-Family AGRILINAE.

Antennal poriferous pits terminal; antennal cavities broad and situated at some distance from the eyes; front constricted at the insertion of the antennae; base of prothorax sinuous at the sides and lobed in the middle; tarsal claws toothed or appendiculate.

A very large sub-family of small or minute buprestids, including species of very considerable economic importance both in forestry and agriculture.

Besides a large number of smaller genera, the sub-family contains the two very large genera of minute buprestids *Agrilus* and *Trachys*.

CORAEBUS.

Coraebus cingulatus, Hope.

REFERENCE.—Hope, Gray, *Zool. Misc.* i, 25 (1831).

Habitat.—Mussoorie, North-West Himalaya. Neither of the specimens in the London and Berlin Museums bears any definite locality.

Shrub Attacked.—*Rubus niveus.* Mussoorie, North-West Himalaya.

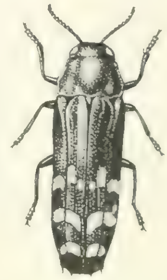


FIG. 144. *Coraebus cingulatus*, Hope. N.W. Himalaya.

Description.

Beetle.—Sub-parallel, rather widened in upper third, constricted at extremity. Shining indigo blue with a green reflexion ; three transverse bands of dark violet purple in the apical half of the elytra, the area between these with a short light whitish pubescence. Prothorax channelled longitudinally on either side of the elytral depression. Elytra as wide as prothorax at base, depressed on either side at base, the depressions forming the prolongation of the prothoracic channels. Apex obliquely truncate on either side between an outer long terminal spine and two minor small teeth ; the suture gaping, ridged, ending in a small tooth smaller than the inner pair of teeth. Length, 9 mm. ; breadth, ·8 mm.

Life History.

I have taken this insect abundantly in Mussoorie, almost invariably on *Rubus niveus*. The beetle is very plentiful from the beginning of July to the end of September, pairing during August and September. The eggs appear to be laid on the *Rubus*, but I have never found the larvae. There is only one generation of the insect in the year.

AGRILUS.

Small, narrow, elongate beetles.

Agrilus birmanicus, Kerremans.

REFERENCE.—Kerremans, *Ann. Soc. Ent. Belg.* xxxii, 211 (1892).

Habitat.—Changa Manga, Punjab. Also reported from Upper Burma.

Tree Attacked.—Sissu (*Dalbergia sissoo*). Changa Manga Plantation, Punjab.

Description.

Beetle.—Elongate, very narrow ; black, with the sternal region dull purple. Elytra each with two white spots, one in the middle of the disk, the other at the apex. Head deeply furrowed its entire length, and covered with small transverse ridges. Prothorax as wide at base as at summit, nearly square, longitudinally furrowed medianly with wavy transverse ridges. Scutellum transversely carinate. Elytra granulose, with deep median basal impressions, slightly depressed along suture, sinuate at level of coxae, slightly widened in upper third, constricted at apex, latter with several very sharp teeth and a long median spine. Under-surface less rugose and more shining than the upper ; legs very finely punctate. Length, 9 mm. ; breadth, 2 mm.

A specimen of this buprestid was cut out of the pupal chamber in the sapwood of a large dying sissu-tree at the Changa Manga Plantation, Punjab, on 17 May 1905. An examination of the tree showed that the larval gallery is eaten out in the bast and sapwood of the tree, being carried in an irregular manner.

Life History.

Agrilus brevicornis, Guérin.

REFERENCE.—Guérin, *Rev. Zool.* 328 (1840).

Habitat.—Pondicherry.

Tree Attacked.—*Albizzia lebbek.* Pondicherry.

Beetle.—Bronze-green; under-surface and legs covered with a whitish powdery pubescence. Head as wide as prothorax, covered with fine longitudinal striae; antennae short, scarcely reaching the middle of the eyes. Prothorax slightly constricted behind, posterior edges sinuate; finely and transversely striate. Elytra with apices conjointly rounded; finely punctate and transversely striate. Length, 7 mm.; breadth, 2 mm.

Description.

This beetle has been taken in August on the leaves of *Albizzia Lebbek.* Nothing further appears to be known on the subject of its life history.

Agrilus salweenensis, sp. nov., Steb.

Habitat.—Tharrawaddy; Salween River, Tenasserim.

Tree Attacked.—Pyinkadu (*Xylia dolabriformis*). Tharrawaddy and Salween River.

Beetle.—Very small, elongate, narrow; antennae very short, dark emerald green; front of head brilliant bluish green; vertex of head, prothorax, and elytra dark olive green, the colour darkening on thorax and base of elytra; under-surface bluish black, with a green reflexion. Front of head flat, finely granulose-punctate. Prothorax moderately convex, flattened on sides, anterior margin sinuate, sides rounded in front, posterior angles obtuse; surface covered with very fine irregular transverse striae. Scutellum large, triangular, with a fine transverse impression below the base. Elytra somewhat flattened, depressed on either side of suture in apical half, slightly wider than thorax at base, depressed behind humeral angle, sinuous at level of posterior coxae, widened in upper third, thence constricted to apex; apices conjointly rounded; finely rugose and granulose; under-surface finely granulose. Length, 5.25 mm.; breadth, 1.5 mm. The insect is figured on pl. xv, fig. 7.

Description.

Larva.—Small; head bright yellow, followed by bright pink abdominal segments. Length, 8 mm.

I first took specimens of the small grub of this beetle in pyinkadu-trees in Tharrawaddy at the end of January 1905. The grubs were engaged in eating out small winding galleries in the bast and sapwood of recently felled trees. I subsequently, on 8 to 11 March, took specimens of the beetle just mature and other immature ones, with pupae in their pupal chambers, in a tree felled a few months previously at Kamamaung on the Salween River in Tenasserim. The insect was very abundant.

Life History.

The larva eats out a fairly straight gallery in the bast and sapwood (the bark of this tree is very thin, and the larval gallery even of this small grub therefore grooves the sapwood). The larval gallery appears usually to double back upon itself, the young grub starting in a certain direction and then altering this and curving the tunnel so as to carry it in the opposite one. This procedure is fairly constant. The larval gallery is always tightly packed with wood-excreta and sawdust. When full-fed the grub bores down into the sapwood, eating out a small chamber a quarter to half an inch down, which is parallel to the long axis of the tree. On maturing the beetle crawls up the entrance-tunnel, eats through the bark, and escapes from the tree. Since the beetles were just commencing to issue early in March it is probable that the insect passes through more than one life-cycle in the year. It was very numerous in several trees examined, and is capable of proving a serious pest.

Trachys.

Minute oval beetles.

Trachys lilliputana, Kerremans.

Reference.—Kerremans, *C. r. Soc. Ent. Belg.* xxxiv, 208 (1890).

Habitat.—Belgaum, Konbir, Chota Nagpur.

Tree Attacked.—Unknown. Taken in the forests in Belgaum (Andrewes).

Beetle.—Oval, constricted at the extremity. Dull bronze above, shining black beneath; densely and regularly punctate and covered with a short sparse greyish-yellow pubescence. Prothorax straight anteriorly, trilobed at base, sides rounded. Elytra convex, sharply constricted at apex; punctate with a short scattered pubescence; a longitudinal raised costa runs from the humeral calus to apex parallel to outer margin. Under-surface punctate. Length, 2 mm.; breadth, 1.25 mm.

Description.

This insect was taken by Andrewes in forest areas in Belgaum in May.

Trachys bali, Guérin.

Reference.—Guérin, *Rev. Zool.* 329 (1840).

Habitat.—Pondicherry.

Trees Attacked.—*Albizzia lebbek*, *Arbutilon asiatica*, and *Cochlospermum gossypium*. Pondicherry.

Beetle.—Bronze, slightly pubescent; under-surface the same. Head weakly emarginate, punctate. Prothorax transversal; posterior margin with the median lobe produced; irregularly punctate. Elytra punctate with irregularly placed smooth and shining spaces between the punctures; elytral costae as in last species. Under-surface punctate. Legs smooth. Length, 3.25 mm.; breadth, 2 mm.

Description.

This insect has been taken in August on the leaves of *Albizzia lebbek*, in the large yellow flowers of *Cochlospermum gossypium*, and in the ripe capsules of *Arbutilon asiatica*.

UNDETERMINED BUPRESTIDS.

In Sandal-wood.—At Dhimbun in North Coimbatore, in August 1902, I observed a dead sandal-wood tree which had been badly infested by a buprestid. The bast layer was riddled by the galleries of the larvae, each of which was some inches in length. The grubs pupate in the sapwood. In one of the pupal chambers I took a beetle in a poor state of preservation. It was, however, recognizable as a buprestid. This insect must be borne in mind as a possible pest of the tree if it is at all abundant.

In Teak.—At Natchoung on the Ataran River in Tenasserim I took a full-fed buprestid grub from a pupal chamber between the bast and sapwood of a teak-tree blown down a few months previously. The larva had fed in the bast and was about to pupate.

CHAPTER XII.

POLYMORPHA (*continued*)—Family ELATERIDAE.

(*Click Beetles.*)

ALTHOUGH species of this family are often to be met with in the forests throughout India, but little is at present known as to their habits. Elaterid larvae are commonly found in the decaying bast and sapwood of dying or dead trees, but few instances are on record of the beetles having been bred from the grubs. On a few occasions I have obtained beetles in this way, as e.g. *Ludigenus* and *Pectocera* which infest the semul (*Bombax malabaricum*) in Assam, *Alaus* in sál wood from Balaghat in the Central Provinces, and two other species, *Lacon* and *Melanotus*, in spruce in the Himalaya. In all these cases the larvae obtained have answered to the well-known circular, hard, shining brown type of elaterid grubs.

Characters.

The elater beetle is easily recognized, the head being sunk in the large prothorax, the latter being squarish in outline, with the posterior angles prolonged into points behind. On the under-surface this prothorax has a pointed process medianly which fits into a cavity or socket on the mesosternum. This arrangement is directly adapted for a special purpose, the insect, which is flat and rather broad in build, when on its back being unable to turn over again. It accomplishes this operation by pressing upwards the pointed process, and thus freeing it sharply from the socket; momentum is thereby obtained, and the insect is shot up in the air, coming down on its ventral surface again. It is owing to this habit, present in some species, that the insect obtains the name of skip-jack or click beetle, a sharp "click" making itself heard when the process is released from the socket. The antennae are often short and serrate, the serration being at times much prolonged. The elytra are very hard, and cover the abdomen. The beetles vary in size from about an inch or more downwards, the larger being often brightly coloured, as in *Alaus putridus* shown in fig. 148. The smaller ones are usually dull-coloured; yellows, browns, and blacks predominating.

Larva.

The grubs of the forest species known are elongate-cylindrical (figs. 30, *d*, and 150), and shining brown or yellow in colour, usually darker above than below, with three pairs of thoracic legs and one or more processes on the last segment. The chitinous covering of the whole grub is extremely hard and horny in consistency, there being but little clear definition of the abdominal segments, which are more or less equal in size. I have taken grubs from two inches in length downwards.

Pupa.

The pupae known are white, yellow, or orange in colour, having the head bent vertically downwards, the wing cases curved on to the breast, and the abdomen elongate (see fig. 150) and often serrate on the lateral edges.

Damage done by the Family.

As serious pests to the bast and wood of trees the family cannot at present be considered a dangerous one. Some species are known to feed on the roots of young plants, and thus to cause serious damage to conifers. In the Himalaya there is at least one elaterid grub which feeds in this manner on the roots of young deodar seedlings, both in the nursery and forest.

The forest elaterid grubs known are, however, in all probability mostly predaceous upon other bast- and wood-feeding insects, especially the bark- and wood-boring beetle pests. It would appear that some of these grubs, if not actually wood-borers themselves throughout their development, at any rate tunnel into the hard wood of trees to pupate, thus ruining its appearance and structure. Such a case is furnished by the large elaterid beetle *Alaus putridus*, the entrances to whose pupal chambers and a chamber itself (in section at the top of the picture) are shown in pl. xvi. In order to settle definitely the relative importance of the family in the forest its further careful study is required.

ADELOCERA.

Adelocera modesta, Boisd.

REFERENCE.—Boisd. *Fauna Ent. Ocean.* p. 108 (1835).

Habitat.—Katha, Upper Burma.

Tree Attacked.—Teak (*Tectona grandis*). Mohnyin Forest, Katha.

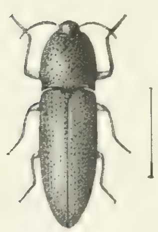


FIG. 145. *Adelocera modesta*, Boisd. Upper Burma.

Description.

Beetle.—Small. Dark rufous brown, shining. Front of head finely punctate. Prothorax convex, longer than wide; the anterior margin concave; posterior angles produced and pointed; uniformly and rather deeply punctate, the lateral margins and basal part clothed with longish sparse hairs. Scutellum large, punctate. Elytra with base depressed, sides gradually constricted to apex; punctate, the punctures arranged in parallel rows and smaller than those on prothorax; scattered yellow hairs laterally and apically. Under-surface highly punctate, the punctures uniformly arranged; covered with a very short sparse scattered whitish pubescence. Length, 12 mm. to 20 mm.

Life History.

I took specimens of this insect from a pupal chamber in the sapwood of a large standing teak-tree which had been girdled in the Mohnyin forests the year before. The larva apparently feeds in the bast and sapwood, and, when full-fed, eats out a tunnel at the end of the gallery down into the sapwood, and hollows out the pupating-chamber in this latter. The beetles found were fully mature and ready to issue from the tree. They were taken on 20 February 1905 in the bole just above the roots.

LACON.

Lacon sp. prox. **davidi**, Fairmaire.

REFERENCE.—Provisionally identified as close to *L. davidi*.

Habitat.—Tehri Garhwal, North-West Himalaya.

Tree Attacked.—Spruce (*Picea morinda*). Deota, Tehri Garhwal, North-West Himalaya.

Description.

Beetle.—Elongate, narrow. Red-brown, covered with a very short, bright golden, fairly close pubescence. Head strongly punctate and densely clothed with a reddish golden pubescence. Prothorax longer than wide, anterior margin emarginate, sides rounded, posterior angles shortly produced, disk moderately convex, depressed at base, strongly and uniformly punctate. Scutellum large, longer than wide, punctate. Elytra depressed at base, elongate, sides straight to posterior coxae, thence rather sharply constricted to apex, latter conjointly rounded; finely and uniformly punctate, the punctures arranged in narrow longitudinal rows. Legs dark brown covered with a yellow pubescence. Length, 13 mm.

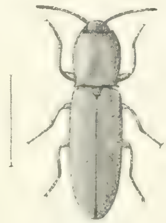


FIG. 146. *Lacon* sp. prox. *davidi*, Fairm. N.W. Himalaya.

I have taken this insect in both larval and beetle stages in dying and dead spruce-trees in the North-West Himalaya.

ALAUS.

Alaus sculptus, Westw.

REFERENCE.—Westwood, *Cab. Orient. Ent.* p. 72 (1848).

Habitat.—Balaghat, Central Provinces. Also reported from Bengal and Assam.

Tree Attacked.—Sál (*Shorea robusta*). Balaghat, Central Provinces.

Description.

Beetle.—Large, broad, rather flat. Black mottled with white patches, the white sometimes predominating; the white patches consist of a thick, close, short pubescence. Head with front black, depressed and punctate medianly, white on either side. Antennae black. Prothorax with usually a black area on disk of greater or less size; disk very convex, shining, with depressions and rugosities, bordered laterally by white patches spotted with black; anterior margin deeply emarginate, the basal angles produced, the lateral margins canaliculate. Scutellum small, black, punctate. Elytra depressed basally, rather flat on disk, sides constricted to apex, latter truncate; striate and finely punctate, the areas of white pubescence forming patches and spots of variable size and position. Under-surface black medianly, shining white and spotted laterally. Length, 24 mm. to 36 mm.

FIG. 147. *Alaus sculptus*, Westw. Central Provinces.

Life History.

A specimen of this beetle was taken from a pupating-chamber in a large sál-log sent to Dehra Dun from Balaghat, Central Provinces, as infested with the longicorn *Hoplocerambyx spinicornis*. The beetle was found dead in the chamber on 15 July 1905, the logs having been sent to Dehra from Balaghat shortly before. I know nothing further about this insect.

Alaus putridus, Candèze.

REFERENCE.—Candèze, *Mon. Elater.* vol. i, p. 233, pl. 4, f. 15 (1857).

Habitat.—Salween River, Tenasserim.

Tree Attacked.—*Dalbergia cultrata.* Kowloon Island, Salween River, Tenasserim.

Beetle.—Elongate, rather narrow, with short antennae. A greyish mottled brown having a great resemblance to the bark of a tree; the greyish appearance on living specimens is due to a grey bloom emanating from the grey pubescence appearing in patches and spots on the dorsal surface; this disappears after death, the colouring becoming various shades of brown or greyish brown; two small black spots placed centrally on prothorax one on each side of the median line; an elongate crescent-shaped black patch laterally half-way up elytra. Front of head deeply cleft on lower edge, punctate, and clothed with a dense pubescence. The anterior margin of prothorax is raised into two small teeth one on each side of a longitudinal median elevate line which does not meet either margin. Disk highly punctate and convex, the highest point just behind the two small teeth, from whence it slopes backwards and laterally; the outer posterior angles produced into long blunt points. Scutellem elongate, elliptical. Elytra depressed basally, the sides constricted to apex; striate-punctate, the punctures rather far apart in even rows; patches of white pubescence on surface; apex truncate and toothed. Under-surface densely clothed with a short pubescence; punctate. Length, 20 mm. to 37 mm.

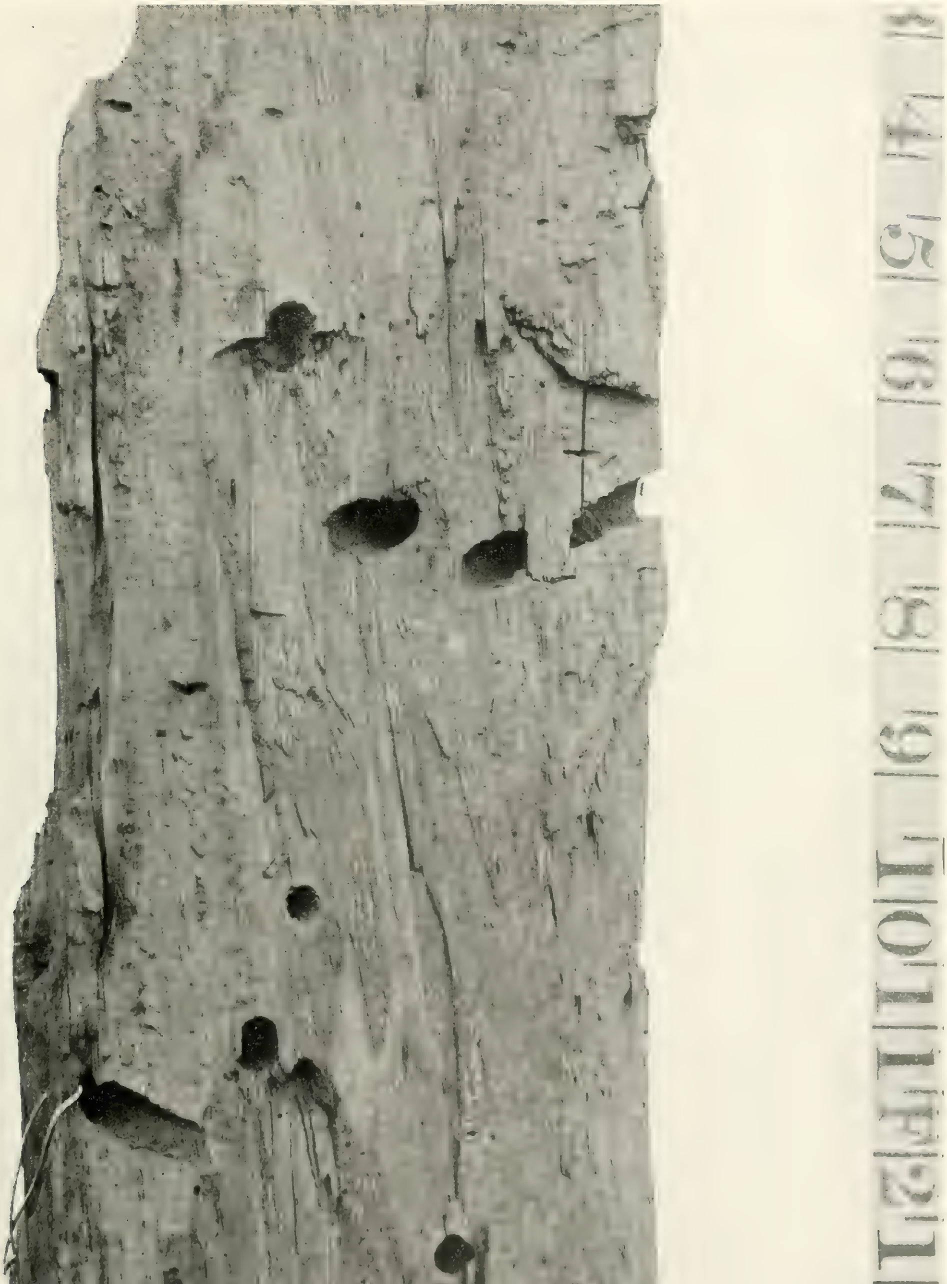
Description.

FIG. 148.
Alaus putridus, Candèze.
Tenasserim.

Life History.

I took two specimens of this beetle in their pupating-chambers in the wood of a dead *Dalbergia cultrata* tree, on Kowloon Island, in the Salween River. The tree was only recently dead. The insects were fully mature and about to issue. Other tunnels and chambers investigated were found to be empty, the beetles having left. The beetles were taken on 10 March 1905, the flight-time being evidently the first weeks of this month. The tunnel into the wood made by the larva is circular in section, the length 3–8 in. straight or curved, and inclined at an angle to the perpendicular. The end of the tunnel is lined with chewed fibre for the whole of the portion in which the larva lies when it pupates, the bottom being plugged with a mass of the same material. The larva itself feeds either in the drying bark and bast layer and outer sapwood, or it is predaceous upon other wood- and bark-feeding insects, as the circular tunnel into the wood is only made after it has attained its full size.

The colouring of the beetle exactly resembles that of the bark of the tree, the protective resemblance being almost complete. On the bark, whilst ovipositing, the beetle would be extremely difficult to see. I can find no other record of the life history of this insect.



Portion of trunk of a large *Dalbergia cultrata*, showing the pupating-chambers and entrance-tunnels of *Alaus putridus*, Candèze. Salween River, Tenasserim.

The damage occasioned by this insect is probably to the wood alone.

Damage to Tree. The large tree in which the beetles were taken was standing in a clearing, and contained a number of the holes made for pupating purposes by the grubs. Timber infested to this extent would stand little chance of being disposed of at timber rates. Pl. xvi shows the extent of the damage done.

Ludigenus.

Ludigenus politus, Candèze.

Reference.—Candèze, *Mon. Elater.* iv, 236 (1863).

Habitat.—Goalpara, Assam.

Tree Attacked.—Semul (*Bombax malabaricum*). Kachugaon, Goalpara, Assam.

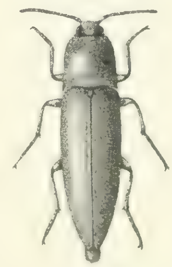


Fig. 149. *Ludigenus politus*, Candèze. ½ Assam.

Beetle.—Elongate, rather narrow. Black with a golden sheen due to the presence of a short, rather sparse golden pubescence.

Description. Antennae and legs dark rufous brown. Head with a median depression on front; strongly and finely punctate. Prothorax convex, the posterior and outer angles produced backwards into a point; uniformly and finely punctate. Elytra but slightly convex, depressed in humeral angles, sides straight to hind coxae, and thence constricted rather sharply to apex; apices separately rounded; finely and very densely punctate. Undersurface dull black; finely reticulate. Length, 30 mm.

Larva.—Elongate, circular in section; dark brown above, lighter-coloured below; blunt and rounded behind. Length, 33 mm.

Mr. Perrée and myself took two mature beetles and a few fully grown

Life History. larvae of this insect in a large, fallen, dry semul-tree in the Goalpara sál forests on 14 May 1906. The grubs were in the outer sapwood, the beetles in pupal chambers in tunnels which had been gnawed deeper down into the sapwood. The grubs appear to feed in the drying bast and sapwood, or they may be semi-predaceous.

Pectocera.

Pectocera cantori, Hope.

Reference.—Hope, *Proc. Zool. Soc. Lond.* p. 77 (1872).

Habitat.—Goalpara, Assam.

Tree Attacked.—Semul (*Bombax malabaricum*). Kachugaon, Goalpara.

Beetle.—Elongate, narrow, the head furnished with a pair of antennae, a number of whose joints are produced into long lamellae, forming a fan-shaped process. These

Description. antennae are folded side by side, and rest pressed against the abdomen of the beetle. Red-brown or dark brown in colour with patches of golden yellow pubescence giving a greyish appearance to the beetle. Head deeply cleft between the eyes, finely punctate. Prothorax longer than

wide, the anterior outer angles shortly produced, the posterior ones produced into long points ; the disk slightly convex, with a short longitudinal median channel ; rather strongly punctate, and covered, as is the head, with a long, sparse pubescence. Elytra long, narrow, constricting in apical third to a sharp tooth ; striate-punctate, the striae well marked at the base, but less prominent apically. Under-surface punctate, covered with the sparse yellow pubescence. Length, 25 mm. to 38 mm.

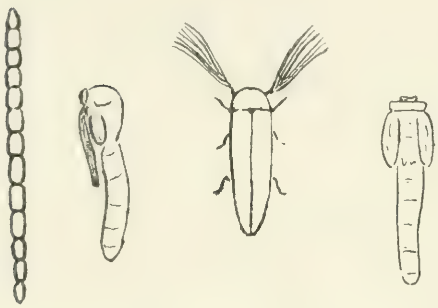


FIG. 150.—*Pectocera cantori*, Hope. Larva, pupa, and beetle bred from semul. Goalpara, Assam. (E. P. S.)

Larva.—Elongate, narrow, cylindrical; yellowish brown and shining in colour. Very hard and horny.

Pupa—Elongate, with a long abdomen. The head covered by the thorax, which is large, having the wing-cases folded over on to the under-surface and covered by the antennae, which lie pressed to the ventral surface of the abdomen.

Life History.

In company with Mr. W. F. Perrée, I took specimens of the larva, pupa, and beetle of this insect in the rotten wood of a large blown-down semul-tree in the middle of May, at Kachugaon, in Goalpara. The larvae were apparently predaceous, feeding upon one or more of the numerous wood-boring insects present in the tree. To pupate, the grubs eat out small elongate chambers in the wood.

AGONISCHIUS.

Agonischius metallicus, Candèze.

REFERENCE.—Candèze, *Elat. Nouv.* fasc. 5, p. 62 (1892).

Habitat.—Darrang, Assam.

Tree Attacked.—? *Ficus elastica.* Charduar Rubber Plantation, Darrang, Assam.

Beetle.—Elongate, rather narrow. Black, shining, with a coppery metallic reflexion. Head strongly and finely rugose-punctate. Prothorax convex in front, depressed behind, sides almost straight; the posterior angles produced outwards into long pointed processes. Scutellum elongate, punctate, and large, depressed between the elevate convex shoulders of the elytra ; latter striate-punctate, the striations most prominent on basal portion ; lateral fourth declivous, finely striate-punctate, and covered with a short, rather dense yellow pubescence, which also sparsely clothes the lateral surfaces of both elytra and prothorax and all the head. Abdomen reddish coppery. Length, 18.5 mm.

Description.

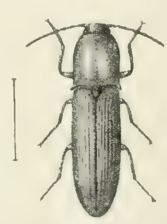


FIG. 151. *Agonischius metallicus*, Cand. Assam.

I took a specimen of this elater on 7 April 1906, in the Charduar Rubber Plantation. The beetle was taken on a leaf of one of the trees.

CARDIOPHORUS.

Cardiophorus sp. prox. maer (?), Candèze.

REFERENCE.—Provisionally identified as probably close to *C. maer*.

Habitat.—Tharrawaddy, Lower Burma.

Tree Attacked.—*Cephalostachyum pergracile*. Kadin Bilin, Tharrawaddy.

Beetle.—Small, elongate, narrow. Yellowish brown, head and prothorax red-brown. Head finely punctate. Prothorax convex, anterior margin sinuate, sides rounded; finely rugose-punctate. Elytra finely striate-punctate, sides straight to posterior coxae, thence constricted to apex, apices conjointly rounded. Legs and antennae yellowish brown. Length, 8.5 mm.

Description.

[Description from a single specimen in poor condition.]

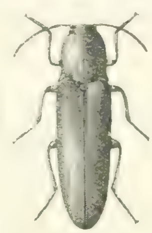


FIG. 152.
Cardiophorus sp. prox. *maer* (?), Candèze.
Lower Burma.

Life History.

I cut a single specimen of this beetle from the dead wood of the wall of a large, hollow, dry *Cephalostachyum pergracile* bamboo, in the Kadin Bilin Forest, Tharrawaddy. The larva had lived in the innermost layer of the wood, and when full-fed had tunnelled deeper into the wall and eaten out a pupating-chamber there. In this I took the beetle on 27 January 1905. The beetle was fully mature and ready to issue.

Cardiophorus sp.

Habitat.—Vellore, Madras.

Tree Attacked.—Casuarina (*Casuarina equisetifolia*). Vellore, Madras.

Beetle.—Elongate, narrow, small, moderately shining. Head and prothorax black, elytra red-brown, with a longitudinal black band down the suture, decreasing in width to apex. Prothorax very convex, smooth, very finely punctate, the outer posterior angles but slightly produced. Scutellum large, impressed in centre. Elytra strongly striate-punctate, the striae strongest basally; sides sharply constricted to apex, which is conjointly rounded. Under-surface dull, punctate; legs brown. Length, 12 mm.

Description.

Life History.

A specimen of this elater was sent by the District Forest Officer from Vellore, Madras, in company with *Sinoxylon sudanicum*, the insects being reported as injurious to *Casuarina equisetifolia* in plantations in that district. The *Sinoxylon* has been already described on p. 176. I am unable to say whether the elater was doing any damage to the tree.

MELANOTUS.

Melanotus sp.

Habitat.—Tehri Garhwal, North-West Himalaya.

Tree Attacked.—Spruce (*Picea morinda*). Deota, Tehri Garhwal, North-West Himalaya.

Description.

Beetle.—Elongate, rather flat. Black, shining, the elytra with a reddish tinge which is most pronounced in apical portions; abdominal segments reddish coppery, glabrous. Head with a median depression on front which is strongly and highly punctate. Prothorax longer than wide, anterior margin straight; sides slightly rounded, the posterior angles produced outwards and then downwards into a blunt point; the disk moderately convex, punctate, the punctures large but not so close as on head; a long sparse yellow pubescence on lateral edges. Elytra elongate, narrow, constricting slightly from posterior coxae to apex, apices conjointly rounded; striate-punctate, the striae and punctures not well marked in basal half except in basal depression which encloses the large heart-shaped scutellum. Undersurface smooth, shining, punctate, with a sparse pubescence. Abdominal segments shining, punctate. Length, 24 mm.

FIG. 153. *Melanotus* sp. N.W. Himalaya.

Life History.

I have taken this insect in all stages of larva, pupa, and beetle, in the bast and sapwood of dying and dead spruce-trees and spruce-stumps in the North-West Himalaya. The grub is, I think, predaceous upon other wood- and bast-boring insects. It, however, penetrates into the wood to pupate. The tunnel made into the wood is circular in section, the pupal chamber being elongate and considerably broader. The insect was taken in June.

Undetermined Elaters.

REFERENCE.—Stebbing, *Depart. Notes*, i, 89 (1902).

Habitat.—North-West Himalaya.

Trees Attacked.—Deodar (*Cedrus deodara*): Taranda Forest, Bashahr State; *Castanea vesca*: Jaunsar, North-West Himalaya.

Larvae.—1. Larva light reddish-brown in colour, with a horny, shiny, chitinous external covering; flat in section, with three pairs of prolegs on the first three segments of the body. Length, $1\frac{1}{4}$ in. This larva is shown in the figure.

FIG. 154.—Deodar Elater Larva. × 2. N.W. Himalaya.

2. Larva brown in colour, hard, shining, with three pairs of prolegs on the first three segments of body. Length, $\frac{1}{2}$ in.

Information at present possessed concerning these larvae.

1. One specimen of this "wireworm," as the grubs of elater beetles are called, was discovered feeding at the roots of an English chestnut plant (*Castanea vesca*) in a small plantation near Kathian, in the Jaunsar Division, North-West Himalaya. It was noticed that several of the young plants, which had been raised from seed sent out from home, were dying or dead, and the cause was attributed to bad planting in several cases. One young plant that I dug up had its roots rather badly gnawed, patches of bark having been peeled off. This wireworm, a large specimen, was found at the roots, and was responsible for the bad condition of the young plant.

2. These small wireworms were found in patches of deodar seedlings in the Taranda Forest, in Bashahr, which were being destroyed by large melolonthid larvae. The elaters were not very abundant, and their attack was distinguishable from that of the cockchafer grubs, since they only cut the roots beneath the surface of the soil. The young plants were seen to be dead or dying without any apparent cause, until they were pulled up, when they came away in the hand, the roots having been cut clean through. Grubs of this family move down lines of young nursery plants in Europe, cutting through the roots in this manner.

Protection.

To clear the soil from such pests, digging in quicklime is recommended, when it can be done with safety, before putting in the seed. Flooding nursery beds and allowing them to stand under water for a time is a good method. All grubs appearing above the surface should be collected and killed, unless the flooding is done so as totally to submerge the beds. Watering the beds with a solution of copper sulphate is also at times effective.

Other Undetermined Elaterid Larvae and Pupae.

Elaterid larvae have also been taken :

1. In *Milletia brandisiana*, in the Kadin Bilin Forest in Tharrawaddy, on 23 January 1905. A number were taken beneath the bark of a stump of this tree in a 1904 tounggya clearing. I am of opinion that the grubs were probably predaceous upon termites which infested the stump.

2. At the roots of dying *Dalbergia sissoo* trees in the Changa Manga Plantation, on 19 May 1905. The larvae were here feeding upon the roots of the tree. I took one pupa on this date, but no mature beetles.

CHAPTER XIII.

HETEROMERA.

THE tarsi of the first two pairs of legs have five joints, those of the hind pair four joints.

Family TENEBRIONIDAE.

This is a curious family of dark-coloured beetles, members of which are to be found distributed throughout the forests of the country, occasionally in considerable abundance. Some forms resemble predaceous Carabidae, whilst others bring to mind the lamellicorns, owing to the existence of horns on the head.

Beetle.

The beetle is elongate or squarish in shape, the elytra often rounded and convex; the parts fit well together, giving the insect a compact and often flattened form. In some cases the elytra are soldered together, lower wings being absent. The antennae are short and eleven-jointed, the abdominal segments five in number. Blacks or very dark browns and greys are the predominant colourings in the family.

Larva.

The larva of this family resembles the elaterid larva, being elongate and circular in shape, and covered with a thick brownish or yellowish hard coat of chitin; there are three pairs of thoracic legs used in walking, and a ventral process used in wood-living species as a sucker, and two hooks on the last segment (cf. fig. 159).

The pupa is yellowish white, convex dorsally, with a vertical head, hooded thorax, the abdominal segments corrugated, the last ending in two processes (figs. 157, 159).

The exact importance of this family cannot as yet be definitely stated. A number of forms feed on dead and decaying materials—bark, wood, leaves, fruits, etc.—but are of small economic utility. It is by no means certain, however, that this function, or even that of sap-feeding from dying or newly felled trees, forms the habit of the greater number of forest forms of the family. Some species investigated are undoubtedly predaceous, whilst others would appear to be bark- and wood-borers to some considerable extent. From observations and investigations carried out, I should be strongly averse to relegating the family to the position of mere scavengers, or to commit myself to the statement that it contains no pests in the forest. The habits of the genus *Setenis*, as will be shown, would appear to indicate that some members of the family are wood-feeders and borers. The grubs of the genus *Hypophloeus* are at least semi-predaceous upon bark-borer grubs.

SETENIS.

Setenis indosinica, Fairm.

REFERENCE.—Fairm. *Ann. Soc. Ent. Belg.* xxxvii, 290 (1893); xl, 168 (1896).

Habitat.—North-West Himalaya.

Tree Attacked.—Blue Pine (*Pinus excelsa*). Lambatach, Jaunsar.

Description.

Beetle.—Elongate, rather broad. Black, dull. Head flat, widest medianly, finely punctate; antennae short, placed marginally. Prothorax wider than long, broader than head, sides rounded, disk moderately convex, finely rugose-punctate, with a fine median longitudinal line, the basal margin channelled. Elytra broad, sides almost straight to apical fourth, thence rather sharply constricted to apex; disk flat, with fine longitudinal rows of regular punctures placed at rather wide intervals; apical part depressed; pygidium small. Legs long, black, shining, the anterior femora thickened. Length, 27–28 mm.

FIG. 155. *Setenis indosinica*, Fairm. N.W. Himalaya.

Life History.

This beetle was taken from beneath the bark of dead blue pine-trees at Lambatach in Jaunsar in the middle of June. The beetles were either just maturing in the trees or were pairing beneath the bark. Beetles were taken from both sound timber and trees which had been dead for several years. They were also found in large stumps of trees of this pine.

I observed a pair of the beetles *in coitu* on 19 May 1902, under the thick lower bark of a girdled nearly dead blue pine, and kept the pair under observation for several days. The eggs are laid on the sapwood, and the grubs feed here, tunnelling down into the wood to pupate. I took no pupae in this tree, but found the pupal chambers at some distance down in the wood.

The beetles are very shy insects, and if alarmed will remain without movement for a long period of time. They dislike daylight, and at once make for a shadow or dark corner if exposed to it.

The beetles have under-wings, and the elytra are not soldered together.

Setenis semiopaca, Blair, sp. nov.

REFERENCE.—Blair, *Ann. Nat. Hist.* (ser. 8), xii, 57 (1913).

Habitat.—North-West Himalaya. Also reported from Sylhet, Assam.

Trees Attacked.—Spruce (*Picea morinda*): Deota, Jaunsar; Blue Pine (*Pinus excelsa*): Lambatach, Jaunsar.

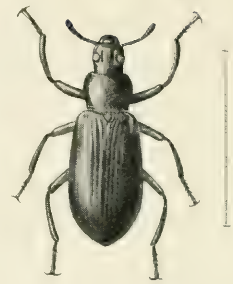


Fig. 156.
Setenis semiopaca.
N.W. Himalaya.

Description. **Beetle.**—Smaller than *indosinica.* Elongate, somewhat narrow. Black, moderately shining. Head slightly convex, lateral anterior margins raised in front of eyes, the elevation being continued down the inner surface of eye, forming a crescent-shaped ridge on either side of vertex; finely punctate; antennae short. Prothorax wider than long, narrower behind; anterior margin straight, posterior emarginate, sides rounded; moderately convex, a lateral depression on either side of centre of disk; finely and closely punctate. Elytra broader than prothorax, widest in apical fourth, thence constricting to apex; apical portion depressed; disk moderately convex, sloping laterally, surface smooth with longitudinal rows of very fine punctures, at times confluent, placed far apart, the interspaces set with very fine scattered punctures, the sides and posterior declivity with minute granules; pygidium short, yellow. Under-surface black, shining, strongly and finely punctate. Legs long, rather slender, black, shining; femora thickened and unarmed. Length, 21 mm. to 23 mm.

This and three other species of the family have been very kindly described for me by Mr. K. G. Blair, of the British Museum.

Pupa.—Large, thick, elongate, rather curved, whitish yellow. Prothorax large and hood-like; body segments thick, fleshy, and tuberculate, the last ending in two processes. Legs long and well developed; antennae short. Length, 37 mm.

Fig. 157.
Pupa of *Setenis semiopaca.* N.W. Himalaya. (E. P. S.)

Life History. I first obtained mature individuals of this beetle from the bark and wood of a large girdled and newly dead spruce-tree near Deota in Jaunsar in the middle of June 1902. This tree was very badly infested by the great Himalayan Sirex, *S. imperialis,* and other wood-boring Siricidae. A few days later I obtained mature beetles of *S. indosinica,* and pupae which at the time I thought to be those of *S. indosinica,* from blue-pine trees at Lambatach. I was able to rear one of the pupae, the beetle maturing on 2 July (from a white pupa taken on 19 June). It proved to be an undescribed species of *Setenis.* The grubs had obviously fed on the wood of the tree, pupating when full-grown deeper down in the wood.

Fig. 158.
Setenis laevis, Fairm.
Assam.

Setenis laevis, Fairm.

Reference.—Fairm, Notes, *Leyd. Mus.* xviii, 230 (1896).

Habitat.—Assam.

Tree Attacked.—Sál (*Shorea robusta*). Haltugaon and Kachugaon, Goalpara.

Description. **Beetle.**—Elongate, thickened behind. Head and prothorax black, dull; elytra chestnut brown, moderately shining. Head widest in front; eyes large, set well into sides of head about middle; strongly punctate and rugose, slightly canaliculate anteriorly. Prothorax wider than long, narrowest behind, sides rounded; disk rather flat, with a deep pit placed rather behind the middle on either side of a fine longitudinal median line; punctures fine and

very scattered. Elytra widest in apical fourth, thence constricted sharply to apex; moderately convex and depressed behind; punctate, the punctures in longitudinal rows placed rather far apart, the individual punctures at some distance from one another. Legs elongate, black, and shining. Length, 22 mm.

Fig. 159.
Larva and pupa of *Setenis laevis*. Assam. (E. P. S.)

Larva.—Elongate, narrow cylindrical, outer surface very hard and thickened; dark chestnut brown to blackish in colour, the segments marked by a dark narrow transverse band; three pairs of legs are present which are functional. Length, 30 mm. to 36 mm.

Pupa—Thick, curved, whitish yellow, the prothorax hooded, the abdominal segments slightly tapering and narrower than thoracic ones. Length, 28 mm.

Life History.

This tenebrionid beetle is very plentiful in dead sál-trees in the Assam sál forests. In the first fortnight in May 1906 Mr. W. F. Perrée and myself took it in all stages of larva, pupa, and beetle, in the trees.

Setenis semivalga, Blair, sp. nov.

Reference.—Blair, *Ann. Mag. Hist.* (ser. 8), xii, 57 (1913).

Habitat.—Central Provinces. Also from Ceylon (Bates Coll.).

Tree Attacked.—Sál (*Shorea robusta*). Kudrahi, Mandla.

Beetle.—Elongate, the elytra much broader than the head and prothorax. Black. Head flat, narrow, broadest medianly, punctate.

Description.

Prothorax wider than long, sides but slightly rounded, the median furrow entire and prominent, the pits on either side small and inconspicuous; punctate, the punctures rather fine and scattered. Elytra slightly wider in apical fourth, thence constricted to apex; apical fourth depressed; moderately convex; strongly and rather deeply striate-punctate, the striae rather close together and rather coarsely punctured, the interstices convex. Legs long, black, shining; anterior tibiae thickest and subdentate in middle. Length, 23 mm.

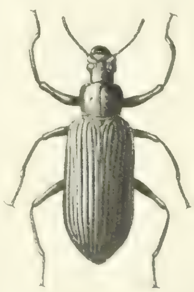


Fig. 160.
Setenis semivalga. Blair, sp. nov. Central Provinces.

I took a specimen of this insect, in April 1909, from beneath the bark of a green sál-tree felled the previous February in the Mandla sál forests.

Hyperops.

Hyperops unicolor, Herbst.

Reference.—Herbst, *Kaf.* viii, p. 193, t. 127, f. 2 (1799).

Habitat.—Madras.

Tree Attacked.—Casuarina (*Casuarina equisetifolia*). Vellore.

Fig. 161.
Hyperops unicolor, Hbst. Vellore, Madras.

Beetle.—Small, elongate. Black, dull. Head flat, widest medianly; very finely and uniformly punctate. Prothorax longer than wide, narrowest behind; anterior margin concave, sides rounded; moderately convex, finely and uniformly punctate. Elytra elongate, narrow, sharply constricted and depressed in apical

fourth; disk rather flat, punctate, the punctures very fine, placed in longitudinal rows. Legs black. Length, 7.5 mm. to 8 mm.

Specimens of this insect were sent to me by the District Forest Officer in Vellore, with the report that they had been taken from casuarina-trees in a plantation in that district.

HYPOPHLOEUS.

Hypophloeus flavipennis, Mots.

REFERENCE.—Mots. *Études Ent.* vii, 99 (1859).

Habitat.—North-West Himalaya; Siwaliks.

Trees Infested.—Blue Pine (*Pinus excelsa*), Spruce (*Picea morinda*), Deodar (*Cedrus deodara*), and the Chilgoza Pine (*Pinus gerardiana*): North-West Himalaya; *Erythrina suberosa*: Siwaliks.

Beetle.—Small, elongate, flat, shining. Head large, exposed, black, and punctate. Antennae short, yellow, as are legs. Prothorax black, longer than wide, narrower in front, squarish behind, sides rounded, moderately convex and uniformly punctate. Elytra rufous brown, elongate-elliptical, rounded at their apices; finely but broadly striate, with scattered punctures; pygidium brown. Under-surface black, shining, punctate; five visible ventral segments of the body. Length, 3.5 mm. to 3.9 mm. (See fig. 162.)

Description.

Life History.

This little beetle is one of the commonest insects present in newly felled or dying and newly dead blue pine, spruce, and deodar trees in the North-West Himalayan forests. The beetle is often found swarming in the galleries of the *Polygraphus*, *Tomicus* (p. 510), and *Pityogenes* bark-borers which infest these trees, and even in those of the scolytid beetles in deodar. The beetle itself probably feeds only on the sap of the tree, but I am of opinion that its larvae are predaceous or semi-predaceous, feeding upon the grubs of the bark-borers when these are available. As I have said, the beetles are at times to be found swarming in incredible numbers in the egg-galleries of the bark-boring beetles and ovipositing in them.

FIG. 162.
Hypophloeus flavipennis, Mots.
N. W. Himalaya.
Siwaliks.

In the middle of February 1902 Student B. Sen Gupta, of the Imperial Forest School, took specimens of a beetle, which were identified at the British Museum as *H. flavipennis*, from under the bark of a recently felled dead *Erythrina suberosa* tree at Bulawala in the Siwaliks.

Hypophloeus sp. nov.

REFERENCE.—Determined as an undescribed species of *Hypophloeus* by Herr H. Gebien.

Habitat.—North-West Himalaya.

Tree Infested.—*Pinus longifolia.* Jeramola, Jaunsar.

Beetle.—Small, elongate. Brown, shining, the elytra yellowish, the lateral edges and suture black, widening out into a black patch on the sutural margin in apical fourth;

pygidium and abdominal segments dark brown to black. Head depressed, red-brown on front, very finely punctate. Prothorax rather square, longer than wide, very finely punctate. Elytra elongate, rather narrow, apex truncate; disk rather convex; depressed at apex; finely striate-punctate. Legs light yellow. Length, 2.7 mm. to 3.1 mm.

This insect is probably predaceous upon *Polygraphus longifolia*. I have taken the insect abundantly in the galleries of this beetle in *Pinus longifolia* in Jaunsar (*vide* p. 527).

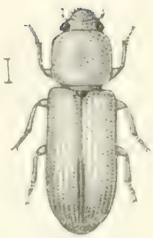


FIG. 162A.
Hypophloeus sp. nov.
N. W. Himalaya.

GONOCEPHALUM.

Gonocephalum depressum, Fabr.

REFERENCE.—Fabr. *Ent. Syst.* Suppl. p. 41 (1789).

Habitat.—Siwaliks and Terai forests of United Provinces; Changa Manga, Punjab. Probably common throughout Northern India.

Trees Attacked.—Sál (*Shorea robusta*): Siwaliks and United Provinces Terai forests; Sissu (*Dalbergia sissoo*): Changa Manga.

Beetle.—Small, flat, ovate-elliptical. Greyish brown or rusty black. Head depressed in front, eyes placed laterally and posteriorly, the antennae inserted in front of them; punctate. Prothorax much wider than long, the anterior margin concave, sides much rounded; disk moderately convex, punctate; elytra wider in apical fourth, thence constricting to apex; apices conjointly rounded; finely striate-punctate. Legs rather short; antennae with the terminal joints knobbed. Length, 6 mm. to 6.5 mm.

Description.

This is a very common beetle, found in large numbers on the bark or stumps of sál-trees. It apparently breeds in dead and decaying wood, and is probably of small economic importance. I have also taken it plentifully beneath the bark of sissu trees at Changa Manga.

Life History.

Gonocephalum elongatum, Guér.

REFERENCE.—Guér. *Mag. Zool.* 1837. Milas. p. 32.

Habitat.—Common in the plains of Northern India.

Tree Attacked.—Breeds in the decaying wood and bark of a variety of species of trees.

Beetle.—Resembles *depressum*, but is narrower, the elytra markedly wider than prothorax, the eyes being situated higher up on head; sides of thorax are curved anteriorly and straight behind; thorax is slightly tuberculate. Elytra gradually widen from base apically, constricting on a uniform curve at apex; punctate-striate, the striae rather far apart. Knobs on antennae not so prominent. Length, 8.2 mm.

Description.

This is another very common species of *Gonocephalum*, and is to be found in the beetle stage almost throughout the year. It is found commonly in the forests, but is probably of small economic importance.

Tribolium.

A genus of small beetles found feeding on dying and dead wood and bark and other materials, and on dried insects, etc.

Tribolium ferrugineum, Fabr.

Reference.—Fabr. *Spec. Ins.* i, 324 (1781).

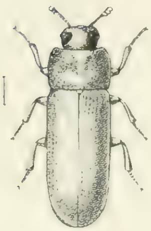


Fig. 163. *Tribolium ferrugineum*, Fabr.

Habitat.—North-West Provinces.

Tree Infested.—Sál (*Shorea robusta*). Dehra Dun.

Description. **Beetle.**—Elongate, narrow, flat. Light brown, moderately shining; under-surface and legs the same colour. Head flat, prominent; the elytra short, thickest apically. Prothorax broader than head, wider than long; sides rounded, moderately convex; punctate. Elytra striate-punctate, the striae most prominent on lateral half; apices conjointly rounded. Under-surface finely punctate, shining. Length, 5 mm. to 7 mm.

Life History. I bred out this insect from sál logs brought by myself from Goalpara in Assam. These logs were cut from green trees in May 1906, and beetles were obtained in Dehra on the 13th (and successive days) of November 1907. It is probable that the eggs from which these insects were reared were laid in the logs whilst in the store depot of the museum at Dehra. The larvae feed in the decaying bark, and are perhaps semi-predaceous upon insect grubs.

Tribolium confusum, J. du Val.

Reference.—J. du Val, *Gen. Col. d'Eur.* Cat. p. 181, nota 1 (1866).

Habitat.—Siwaliks, North India.

Tree Infested.—Bamboo (*Dendrocalamus strictus*). The Dun forests, Siwaliks.

Description. **Beetle.**—Larger than *ferrugineum*. Dark brown in colour, the elytra moderately shining. Prothorax wider than long, highly and uniformly punctate; a narrow depression on each side near basal margin. Elytra constricted apically, the apices conjointly rounded; moderately striate-punctate, the striae less well marked than in *ferrugineum*. Under-surface dull, punctate. Length, 5 mm. to 8 mm.

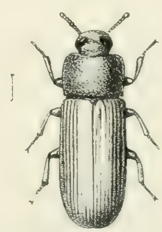


Fig. 164. *Tribolium confusum*, J. du Val. Siwaliks.

Life History. I have obtained specimens of this beetle from drying and dead bamboos cut in the Siwaliks. The bamboos were attacked by *Dinoderus pilifrons*, and this beetle and the *Tribolium* were bred out together. The grubs are not improbably predaceous or semi-predaceous on the bostrychid. They are also predaceous upon the grubs of *Caryoborus* sp., which infests the seeds of *Albizzia lebbek* (*vide* p. 252).

Tribolium castaneum, Herbst.

REFERENCE.—Herbst. *Käf.* vii, p. 282, t. 112, f. 3, E. (1797).

Habitat.—Calcutta.

Tree Infested.—Bamboo (*Dendrocalamus strictus*).

Beetle.—This greatly resembles both in size and appearance *T. ferrugineum*, with which species it is considered by many to be identical.

Life History.

During the experiments carried out with the bamboo-borer *Dinoderus minutus* at the Indian Museum in Calcutta in 1903 I bred out a number of specimens of this *Tribolium*. It and its grubs feed in the walls of the bamboo and perhaps on the masses of wood-powder eaten out by the *Dinoderus* beetles and their grubs. The grubs are probably semi-predaceous, as I have also found them in company with *Caryoborus gonagra* in the seeds of *Bauhinia racemosa* (*vide* p. 252).

Tribolium sp.

REFERENCE.—Determined as an undescribed species of *Tribolium* at the British Museum.

Habitat.—Siwaliks, North India.

Tree Infested.—Sál (*Shorea robusta*). Dholkhand, Siwaliks.

Life History.

Towards the end of January 1902 I obtained specimens of the beetles of a minute *Tribolium* from beneath the bark of some dead felled sál-trees. The beetles were between the bark and sapwood, and were active. It is possible that the insect hibernates as a beetle.

MESOMORPHA.

Mesomorpha villiger, Blanch.

REFERENCE.—Blanch. *Voy. Pol. Sud.* iv, 151, pl. 10, fig. 15 (1853).

Habitat.—Siwaliks and Terai sál forests, North India; Katha, Upper Burma.

Trees Attacked.—Sál (*Shorea robusta*): Siwaliks and Terai, North India; Teak (*Tectona grandis*): Mohnyin Reserve, Katha.

FIG. 165. *Mesomorpha villiger*, Blanch. North India; Upper Burma.

Beetle. Ovate-elongate. Dull brownish black or rusty black. Head depressed, front strongly granulose. Prothorax wider than long, sides strongly rounded; disk convex, strongly granulose. Elytra widest in apical fourth, where they are wider than prothorax; constricted from apical fourth, apices conjointly rounded; rather strongly striate and granulose. Under-surface strongly punctate. Legs rather short. Length, 7.5 mm

Description.

Life History.

I have taken this beetle commonly in March, April, and May in crevices of the bark of sál-trees and on the bark of stumps in the Northern India sál forests, and found the insect beneath the bark and wood of dead trees, where it evidently breeds. I also took specimens of the insect from beneath the bark of a large standing girdled teak-tree in the Mohnyin forests in Katha on 19 February 1905. In this latter case the larvae were found feeding in the bark and outer sapwood.

The beetle only infests dying and dead trees, is found in thatched roofs, and would appear to be of small economic importance. Lefroy in *Indian Insect Life* (p. 336) thus alludes to this insect :—

"A yearly feature is the emergence of numbers of the very common beetle *Mesomorpha villiger*, which breeds in dry leaves and wood, and which emerges abundantly to fly in the warm evenings in March in the plains. In the warm winter of 1907 these beetles emerged on 25 February, an exceptionally early date."

Blaps.

Blaps armata, Blair, sp. nov.

Reference.—Blair, *Ann. Mag. Hist.* 8th ser, xii, 56 (1913).

Habitat.—North Zhob, Baluchistan. Also reported from Chitral.

Tree Attacked.—Chilgoza (*Pinus gerardiana*). Shinghar, North Zhob (Captain E. H. James).

Description.

Beetle.—Large, black, dull ; antennae and legs shining black. Head depressed, longer than wide ; antennae placed at side in front of eyes ; latter reniform, transverse, yellow ; an elevate wavy ridge stretching across front of head between the juncture of antennae ; very finely punctate, punctures scattered. Prothorax wider than long ; sides evenly rounded, base nearly straight, disk moderately convex, with very fine, rather scattered punctures. Elytra elongate-ovate, as wide as prothorax at base, sides evenly rounded ; width greatest in apical fourth, thence constricting to a pointed apex ; disk moderately convex, depressed towards apex ; finely striate with rather scattered, often almost obsolete, punctures, and at times irregularly rugose ; lateral carina completely marginal. Legs long, the anterior femora with a prominent median tooth on inner edge. Length, 27.5 mm. The female only is known.

Fig. 166.
Blaps armata, Blair, sp. n.
♀ North Zhob.

Life History.

Whilst examining infested trees in the chilgoza forests at Shinghar in the autumn of 1908 in North Zhob in Baluchistan, Captain E. H. James, Assistant Political Agent, Fort Sandeman, cut out a specimen of this beetle from a dead tree. The grub has not been taken, but it apparently tunnels down into the sapwood to pupate.

The insect has been very kindly described for me by Mr. K. G. Blair as a new species of *Blaps*.

ENCYALESTHUS.

Encyalesthus foveoseriatus, Fairm.

REFERENCE.—Fairm. *Ann. Soc. Ent. Fr.* (6), viii, 358 (1888).

Habitat.—Mohnyin Forest, Katha, Upper Burma.

Tree Attacked. — *Alstonia scholaris*. Mohnyin Forest.

FIG. 167.
Encyalesthus foveoseriatus, Fairm.
Burma.

Description.

Beetle.—Elongate, the head and prothorax narrower than the elytra, antennae knobbed. Dark brown, with a coppery reflexion, head and thorax almost black, legs dark brown, shining. Head depressed in front, the vertex convex, smooth, shining, the front rugose. Prothorax wider than long, anterior margin indented on either side, disk irregularly elevate, with the punctures scattered and varying in size. Elytra impressed in humeral angle, widest three-fourths up from base, thence sharply constricted to apex; depressed in apical fourth; strongly punctate, the punctures deep and larger laterally in basal three-fourths, small in apical depression; much smaller on sutural area. Under-surface black, shining punctate. Length, 17.2 mm.

This insect was obtained by myself during a tour in Burma. The specimen was cut out of a large felled *Alstonia scholaris* tree on Kadu Hill in the Mohnyin Forest in Katha.

CAMARIMENA.

Camarimena rugosistriatus, Blair, sp. nov.

REFERENCE.—Blair, *Ann. Mag. Hist.* 8th ser. xii, 58 (1913).

Habitat.—North-West Himalaya; "Ind. or." (Bates Coll.).

Tree Attacked.—Deodar (*Cedrus deodara*). Konain, Jaunsar (A. J. Gibson).

Description.

Beetle.—A thickset beetle with small head and prothorax and short antennae. Dull coppery-brown. Head flat, depressed, finely rugose and irregularly striate. Prothorax slightly wider behind, base straight; densely punctate, the punctures largest on disk, and at times confluent with a few wavy striations. Elytra stout, base straight, sides straight to apical fourth, thence constricted on a curve; strongly striate-punctate, the striae deep, the punctures of striae very closely placed and transversely elongate. Under-surface covered with a short silky whitish-yellow pubescence. Legs densely punctate. Length, 18.2 mm.

FIG. 168.
Camarimena rugosi-striatus, Blair, sp. nov.
N.W. Himalaya.

Blair adds the following note to his description of the species:—"This species had been separated by Bates from *Camarimena* under the name *Pigeus*, but without characterization of the genus. For the present, however, until the group comes to be revised, I consider it best to leave it in *Camarimena*."

Specimens of this beetle were taken on young deodar-trees by Mr. A. J. Gibson, Imperial Forest Economist, Forest Research Institute, Dehra Dun. The beetles were obtained on 6 May 1908 at Konain in Jaunsar, and were found feeding on the young male flowers. Two days later the insect was again taken feeding on the flowers, and on this occasion a species of *Cistelomorpha* (*annuligera*, Fairm.) was taken occupied in the same manner (*vide* p. 244).

Life History.

Opatroides.

Opatroides vicinus, Fairm.

Reference.—Fairm, *Ann. Soc. Ent. Belg.* xl, 21 (1896).

Habitat.—Fort Sandeman, Zhob.

Tree Infested. — Vines (*Vitis vinifera*). Fort Sandeman.

Fig. 169.
Opatroides vicinus, Fairm. Zhob.

Beetle.—Ovate-elongate. Black, slightly shining. Head with frontal margin semicircular, surface uniformly densely and finely punctate. Prothorax wider than long, anterior edge straight, sides slightly curved, the posterior angles pointed ; uniformly and finely punctate. Elytra convex, depressed in apical fourth, sides straight to level of posterior coxae, thence constricted, apices separately rounded ; the lateral margin flattened horizontally, the edge finely serrate ; very finely punctate, the rows of punctures rather far apart. Legs short, black. Length, 7.8 mm.

Description.

I took this beetle in the soil at the foot of grape vines in the station garden at Fort Sandeman. The beetle was mature and evidently ready to leave the soil. I have not ascertained whether its larvae feed on the roots of the vine or are predaceous on other grubs which do so.

Life History.

Amarygmus.

Amarygmus cuprarius, Weber.

Reference.—Weber, *Obs. Ent.* p. 70 (1801).

Habitat.—Tenasserim.

Tree Infested.—*Dalbergia cultrata.* Salween River, Tenasserim.

Beetle.—Ovate-elliptical. Dark olive-green with a brilliant metallic-coppery reflexion. Head coppery, small, finely punctate, eyes large. Prothorax much wider than long, anterior margin convex, sides rounded ; finely and rather irregularly punctate. Elytra very convex, elongate, humeral angles rounded, sides rounded, constricting in apical fourth; striate-punctate, the interstitial spaces broad, the punctures small. Legs long, black, shining. Length, 11 mm. to 12.5 mm. ♂ smaller than ♀.

Description.

Fig. 170.
Amarygmus cuprarius, Weber. Tenasserim.

Life History. I took a number of specimens of this beetle from beneath the bark of a large standing dead *Dalbergia cultrata* on Kowloon Island on the Salween River in Tenasserim on 9 March 1905. The beetles were found together beneath the bark in the angle between the wings of the enormous buttress which formed the lower ten feet of the trunk of the tree. The beetles are very active, and ran rapidly up the trunk as soon as the bark was stripped off. The insect is probably carnivorous, and may have been feeding on one or more of the insects with which this tree was infested (*vide* pp. 427, 449, 598).

ALPHITOBIUS.

Alphitobius piceus, Oliv.

REFERENCE.—Oliv. *Ent.* iii, 1795, 58, p. 17, t. 2, f. 13, *a*, *b*.

Habitat.—Tenasserim.

Tree Infested.—Yindiak (*Dalbergia cultrata*). Natchoung Reserve, Ataran River, Tenasserim.

Beetle.—Small; black, moderately shining. Head small, rounded on anterior margin, the edge reddish; finely punctate. **Description.** Prothorax wider than long, the sides rounded, posterior margin thickened; uniformly and densely punctate; scutellum rather large, punctate. Elytra with rounded sides, the apices separately rounded; striate-punctate, the lateral margins flattened horizontally. Legs rather short. Length, 4.5 mm.

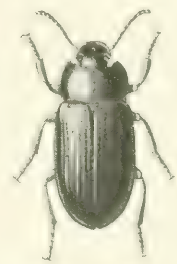


FIG. 171.
Alphitobius piceus, Oliv. Tenasserim.

During a visit paid to the Natchoung Reserve on 16 March 1905, in company with the Divisional Forest Officer, Mr. Parker, I obtained a specimen of this beetle from beneath the bark of a felled *Dalbergia cultrata* tree.

Family CISTELIDAE

The beetles of this family closely resemble Tenebrionidae, but they have pectinate instead of simple claws to the feet. The beetles have long antennae, longer in the male than in the female.

The members of the family are said to live and feed beneath the bark and sapwood of dead and decaying trees, but some species appear to feed on the flowers.

Cistelomorpha andrewesi, Fairm.

Habitat.—Siwaliks, North India.

Tree Infested.—Sál (*Shorea robusta*). Siwaliks.

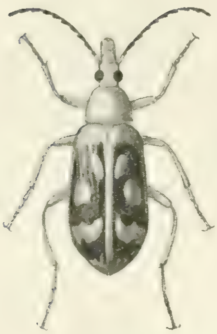


FIG. 172. *Cistelomorpha andrewesi*, Fairm. Siwaliks.

Beetle.—Elongate, widest behind. Dark canary-yellow. Elytra black, the basal sixth canary-yellow, produced on lateral edge with a narrow edging of same colour along suture; a longitudinal egg-shaped yellow spot in basal third near suture, a larger roughly-circular one about middle near lateral margin, a third transversely crescent-shaped with wavy edges three-fourths up, and a fourth at apex. Under-surface dark canary-yellow. Head narrow, elongate; antennae and eyes black. Prothorax widest behind, very finely and closely punctate. Elytra widest three-fourths way up, thence constricting to apex; striate and rugose-punctate, the striae and punctures obsolete in parts. Length, 12 mm.

Description.

I took a specimen of this beetle from beneath the bark of a dead sál-tree in the Dun forests of the Siwaliks. I know nothing further about its life history.

Cistelomorpha annuligera, Fairm.

Habitat.—North-West Himalaya.

Tree Attacked.—Deodar (*Cedrus deodara*). Konain, Jaunsar (A. J. Gibson).

Beetle.—Dark canary-yellow, head and legs orange, apical half of elytra marked with narrow transverse black stripes. Head sloping, finely punctate, a transverse channel between the antennae, which are inserted a short distance in front of eyes. Prothorax broader behind than in front, wider than head, sides rounded in front, straight behind, disk finely reticulated. Elytra shining, smooth, wider than prothorax at base, widest about one-third up, depressed laterally and apically, striate and very finely punctate; an elongate, narrow, elliptical area in basal half enclosed by a fine black stripe, a second egg-shaped area above, nearer lateral margin, and a third larger transverse crescent-shaped area in apical third, both enclosed by fine black bands, these latter being finely rugulose-punctate. Under-surface greenish, abdomen canary-yellow, very finely punctate. Length, 19 mm.

Description.

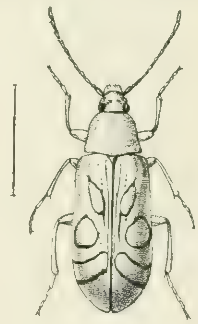


FIG. 173. *Cistelomorpha annuligera*, Fairm. N.W. Himalaya.

Mr. A. J. Gibson, Indian Forest Service, obtained specimens of this beetle feeding, in company with the tenebrionid *Camarimena rugosistriatus*, Blair, already described, on the male flowers of young deodar-trees at Konain in Jaunsar. The beetle was taken on 8 May 1908. This is the only observation on its life history I can find. It is of considerable importance in view of this observation that the habits of the insect should be correctly ascertained.

Life History.

Family LAGRIIDAE.

The beetles resemble Tenebrionidae, but have the last joint but one of the tarsus bilobed and pubescent, the claw being simple. Until comparatively recently nothing was known about the habits of the forest species in India. A member of the family is likely to prove, however, of some economic importance in Assam.

Lagria sp. nov.

REFERENCE.—Determined by Herr H. Gebien as a new species of *Lagria*.

Habitat.—Assam, Buxa Duars.

Tree Attacked.—Semul (*Bombax malabaricum*). Goalpara, Buxa Duars.

Beetle.—Elongate, the head and prothorax small and narrow. Dark indigo-blue, shining. Head inclined at an angle, tuberculate on front, vertex rugose. Prothorax narrower behind, finely punctate. Elytra wider than prothorax, widest two-thirds up, thence constricted on a curve to apex; disk covered with irregular transverse fine striae, the base closely punctate; lateral edges of insect and legs set with sparse coarse hairs. Legs black. Length, 6.2 mm.

Description.

FIG. 174. *Lagria* sp. nov. Assam.

Life History.

During a tour made in April and May 1906 through Goalpara with Mr. W. F. Perrée, he mentioned that he had noted that the semul-trees in the division were seriously defoliated by a small beetle. The semul is of considerable importance in Assam, as the wood is largely used for the manufacture of tea-box planking. I was afforded opportunities for studying this attack.

My investigations showed that the real aggressor was the small weevil *Myllocerus lineatocollis* (*vide* p. 400). Individuals of this small *Lagria* were, however, also present, and were engaged in defoliating the trees.

Family **MONOMMIDAE.**

Lefroy mentions, in *Indian Insect Life*, that this family is represented in India by a single genus and species only. In some respects this insect resembles the oval forms of the Staphylinidae.

Monomma brunneum, Thoms.

REFERENCE.—Thoms. *Monogr. Ann. Fr.* p. 23, t. 2, f. 5 (1860).

Habitat.—North India.

Trees Infested.—Sál (*Shorea robusta*); *Terminalia tomentosa*. Siwaliks and United Provinces Terai forests.

Beetle.—Elongate, convex, dark brown in colour. Head small, not hidden by prothorax, the antennae ending in a club and fitting into grooves in the sides of the prothorax when the insect is at rest. Prothorax narrowest in front; shining-punctate; elytra rather coarsely striate-punctate. Length, 9 mm.

Life History.

This beetle is found occasionally beneath the bark of sál and *Terminalia tomentosa* trees in North India and, I think, in the Chota Nagpur sál forests. The beetle is either a dead-bark or sap feeder, but I know nothing of the habits of the larvae nor where the eggs are laid.

The family is only represented by this species in India, and cannot be considered at present to have any economic importance in the forests.

Family PYTHIDAE.

A small family, closely resembling the Tenebrionidae, from which they differ by characters of small importance save to the systematist. The family contains a small heteromerous forest form, found under the bark of trees. In fact, evidence is showing that it is probable that the forests of India will add a number of new species of minute bark-living forms to these heteromerous families.

Doliema spinicollis, Fairm.

REFERENCE.—Fairm. *Ann. Soc. Ent. Fr.* lxii, p. 27 (1893).

Habitat.—Siwaliks, North India.

Tree Infested.—Sál (*Shorea robusta*). Dholkhand, Siwaliks.

Beetle.—Elongate, small. Head black, prothorax very dark brown; elytra, antennae, and legs lighter brown. Head flat, widest across middle, very finely punctate; antennae short, the joints thickening to apex. Prothorax wider than long, anterior edge straight, sides rounded to near base, thence straight; disk flat, very finely punctate. Elytra with base straight, sides straight to posterior coxae, thence gradually constricted, apex rounded; strongly striate-punctate, the punctures small, the interspaces raised; a few scattered spiny yellow hairs on surface. Length, 4 mm.

Description.

This small insect is to be found beneath the bark of felled and drying sál-trees in the Dun forests of the Siwaliks. I took it in this position towards the end of January, but know nothing about its habits nor those of its larva.

Family CANTHARIDAE.

A family of beetles easy to recognize owing to the moderate-sized head being joined on to the prothorax, which is narrower than the head, by a "neck." In external form the insects resemble to some extent the malacoderms, as the elytra are rather soft and do not fit well together or cover the abdomen. The antennae are long and simple; the legs long, with elongate tarsi and an appendage to the claw. Some of the common forms are vividly marked with bands of colour—red, orange, etc.—whilst others are of brilliant metallic hue throughout, blues and browns; others, again, are dull browns or blacks or purples. The forest species known reach up to about $1\frac{1}{2}$ in. in length.

Many of these insects fly and run quickly and well, and are to be found on the wing both in the sunshine and heavy rainy weather. Some forms appear to move about in swarms after the fashion of the locust or the bark beetles. The beautiful green *Cantharis antennalis* has this habit in the

Western Himalaya, and the traveller may occasionally in the early summer suddenly find the road and neighbouring jungle covered by a crawling mass of this very beautiful cantharid.

The genus *Meloe* is wingless, the elytra also being very short.

In habits the family varies. Some forms feed on the leaves and flowers of plants, shrubs, and trees, others eating the fruits. The habits and life histories of the forest forms are not well known. The insects are of some commercial importance owing to the oil which they excrete. This comes from the femora of the legs, and is present in the genera *Mylabris*, *Cantharis*, and the wingless *Meloe*.

MYLABRIS.

Mylabris pustulata, Thunb.

REFERENCE.—Thunb. *Diss. Nov. Spec. Ins.* vi, p. 113, f. 13 (1791).

Habitat.—Throughout Northern India.

Trees Attacked.—*Artocarpus* sp., *Hibiscus*, and other garden shrubs. Dehra Dun.

Description.

Beetle.—Elongate, black, the elytra marked with orange or red bands and blotches. Head large and prominent, broader than prothorax anteriorly and attached to it by a slender neck; the black antennae rather short, thickest apically. Head densely punctate and pubescent beneath. Prothorax widest medianly, densely punctate, disk very convex with a central depression, margins and under-surface set with a long dense black pubescence. The elytra are soft and leathery, wider than the prothorax at the base, rounded and broadest apically. They are pent-roof shaped and do not meet accurately along suture. A rounded yellow or orange blotch near the base; an irregular transverse band just below the middle and a second usually broader zig-zag one in apical third. Under-surface black, pubescent, and punctate. Length, 18-29 mm.

FIG. 175.
Mylabris pustulata, Thunb.
Northern India.

Life History.

In Northern India, at Dehra Dun, this beetle makes its appearance on the wing at the beginning of July, soon after the burst of the monsoon, and may be found from then onwards till October; it is in greatest abundance perhaps in July and August. The beetles feed on the leaves, green rind of twigs, and flowers of a variety of shrubs. They are particularly fond of the *Hibiscus*, of which they destroy the flower-buds, petioles, and leaves, and strip the rind from the green shoots. When abundant I have also watched them feeding on the fruit of a species of *Artocarpus* in Dehra, peeling and stripping the pericarp down to the stone. Half a dozen beetles will easily strip a fruit to the stone, and the injury done to shrubs and small trees, more especially in the garden, in a year when these beetles are very numerous, is extensive.

I think it is quite possible that the insect may pass through two generations during the monsoon, the insects occurring in late September and October resulting from eggs laid in July by the beetles first appearing. This point I have not, however, proved definitely, as I have not been able to rear the larvae. The eggs are laid in bunches on the leaves of shrubs and grass stems near the ground.

To get rid of the beetles in the garden or nursery I have found the best way is to put on boys to collect them by hand and pay them so much for every hundred caught. Each boy should be given a kerosene tin with a little kerosene and water in it. All the beetles collected are thrown into this and counted afterwards.

Cantharis.

Cantharis (Epicauta) antennalis, Mars.

Habitat.—North-West Himalaya.

Tree Attacked.—*Lonicera angustifolia* and *L. quinquelocularis*. Jaunsar.

Description.

Beetle.—Elongate, narrow, brilliantly coloured. Head, basal joint of heavy prominent antenna, anterior half of prothorax, and legs brilliant shining metallic green with a yellow reflexion. The basal half of prothorax and a narrow longitudinal band along elytral suture a dark blue green or purple with a green reflexion; rest of elytra and remaining joints of antennae a rich dull chrome yellow. Head ace-of-clubs-shaped, irregularly punctate, the basal and apical joints of antennae much thickened. Prothorax narrower than head, sides produced into a point medianly; finely punctate anteriorly. Elytra narrow, sides parallel, apices separately rounded, do not meet accurately along suture; closely and densely reticulate. Under-surface brilliant metallic green. Length (without the long, heavily jointed antennae), 24 mm. to 30 mm.

Life History.

This beetle was first reported as defoliating species of *Lonicera* by the Director of the Imperial Forest School, Dehra Dun. The insects were taken on 16 June 1893, and sent to the Indian Museum, Calcutta.

I have taken the insect on several occasions in the same month in the Western Himalaya at elevations of between 7,000 and 8,500 ft., and have found it feeding on the leaves of various shrubs forming the undergrowth of the deodar, spruce, and silver-fir forests of this region. The beetles have the curious habit of keeping together in swarms, at any rate for a time after first emergence on the wing. It is also apparent that a brood of the insects must mature at the same time without a very considerable overlapping of generations. It is a curious experience suddenly to find a swarm of these brilliantly-coloured and handsome insects settling on the path and undergrowth around one, glistening in the sunlight like so many gorgeous jewels. The insects couple towards the end of June. I have not found the larvae.

CISSITES.

Cissites testaceus, Fabr.

REFERENCE.—Fabr. *Spec. Ins.* i, 256 (1781).

Habitat.—Rangoon, Burma; Calcutta.

Habits.

This insect is predaceous upon the carpenter-bee *Xylocopa latipes*, the beetle entering the tunnels in the wood and ovipositing in them. The grubs of the beetle feed upon those of the *Xylocopa*, pupating in the wood when full-grown.

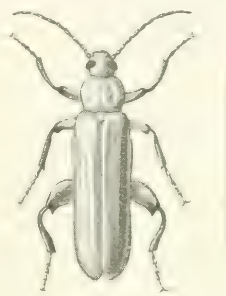


FIG. 176.
Cissites testaceus.
Fabr. Burma.

I took this insect in the tunnels of the carpenter-bee in pyinkadu logs in Calcutta in 1903. The logs were imported from Rangoon a short time previously, and portions of them were kept under my observation at the Indian Museum during the year (*vide Xylocopa*, vol. ii).

Green has recorded * a similar habit in the case of *Cissites debyi*, which oviposits in the galleries of *Xylocopa tenuiscapa*, Westw.

HOLOPELTIS.

Holopeltis 3-cornis, Fairm.

REFERENCE.—Fairm. *Ann. Soc. Ent. Belg.* xxxviii, 22 (1894).

Habitat.—Salween River, Tenasserim.

Tree Infested.—*Schleichera trijuga*. Kowloon Island, Salween River.

Description.

Beetle.—Small, elongate-ovate, flat. Black. Two small teeth on upper part of head, with a larger upcurved brown one on lower part of front, giving the beetle a resemblance to a miniature *Oryctes rhinoceros* (*vide* p. 88). Prothorax wider than long, deeply emarginate on anterior edge, sides curved, widest behind, with an irregular depression on each side of disk just above base; very finely punctate. Elytra moderately convex, sides rounded and flattened horizontally on margin, the flattened part brown; finely striate-punctate, the striations and punctures almost obsolete medianly. Under-surface dark brown, black medianly, finely punctate. Legs brown. Length, 5 mm. to 5.5 mm.

Life History.

I found this small beetle in fair numbers beneath the bark of a standing green *Schleichera trijuga* tree. The insects appeared to be feeding on the sap of the tree. I do not know the larval form. The mature beetles were taken on 9 March 1905 on Kowloon Island in the Salween River in Tenasserim.

* Green, *Ent. Mon. Mag.*, 232, 1902.

CHAPTER XIV.

PHYTOPHAGA.

Tarsus four-jointed, the third joint very often bilobed and pubescent. The head is not prolonged into a beak.

The group contains three families—Bruchidae, Chrysomelidae, and Cerambycidae—the second and third of which are of considerable size.

The Bruchidae will not unlikely prove of considerable importance in the forest as destructive to the seed of many of the plains species of trees.

The Chrysomelidae are leaf-feeders, and cause a certain amount of defoliation.

The Cerambycidae are one of the most important families of bast-eating and wood-tunnelling beetles in the forest.

Family BRUCHIDAE.

The Bruchidae are small hairy beetles, rarely exceeding eight millimetres in length ; the colours greys and dull browns or blacks.

The beetles are commonly found in the seed of some forest trees, especially in the Leguminosae, and their importance in the forest lies in this fact. In all probability a far greater amount of the seed of forest trees is annually destroyed by bruchids than our present knowledge of the family leads us to expect, and for this reason the insects require a close study on the part of Forest Officers. Within my experience, the only Forest Officer who has given this form of attack close investigation is Mr. G. M. Ryan, I.F.S., in the Bombay Presidency.

Beetle. The beetle is small and squat in shape, with a thickened body and thickened hind legs. The head is small, with a short rostrum and serrate or pectinate eleven-jointed antennae. The elytra are truncate, leaving exposed the last segments of the abdomen. The tarsi are four-jointed, the third joint bilobed.

Larva. The grub is white, corrugated, and curved. The eggs are usually laid by the beetles on the newly forming seed-pod, and the larva on hatching out tunnels through the walls of the pod and thence into the seed, which it entirely hollows out, leaving only the seed-skin. When full-fed the larva may pupate within the seed, or leave it and spin a cocoon within the pod and pupate within this.

The beetles to some extent feed upon the leaves of the tree.

Only two species (of the genus *Caryoborus*) are known to be pests in the forest.

CARYOBORUS.

Caryoborus gonagra, Fabr.

REFERENCES.—Fabr. *Ent. Syst. Suppl.* 159; Stebbing, *Depart. Notes*, 305 (1906).

Habitat.—Throughout plains of India.

Trees Attacked.—*Bauhinia racemosa:* Central Thana, Bombay (G. M. Ryan); Tamarind (*Tamarindus indica*): Calcutta; *Cassia montana:* South Cuddapah, Madras; *Cassia muritura:* Cuddapah, Madras; *Cassia fistula* (the Indian Laburnum): Calcutta; Casuarina (*Casuarina equisetifolia*): Vellore.

Description.

Beetle.—The beetle is greyish or yellowish-brown. It is somewhat elongate, with a small head consisting chiefly of two large prominent eyes; antennae brown. Thorax triangular, narrower in front than behind, hind margin produced backwards into a point medianly. Elytra wider than thorax, with parallel sides, constricted behind, the apices separately rounded; surfaces striate, with longitudinal rows of fine pits down them, and covered with short hair. The elytra rest flat upon the large thick body, which is greyish in colour. The most striking characteristics about the insect are the largely developed prominent femora of the hind legs; these, as is the case with all the legs, are covered with fine hair. Abdomen truncate behind. Length, ♂ 5 mm.; ♀ 6.25 mm.

Larva.—A small whitish curved grub with a distinct yellowish head. Length, 8 mm.

Cocoon.—To pupate the larva encloses itself in a white cocoon.

Life History.

In Bombay the beetles emerge from the *Bauhinia* pods at the end of February and beginning of March. The exact position where the eggs are laid has not yet been reported, but it is probable that they are laid on the flowers or young forming pods, since the tree flowers between March and June. The larva on hatching out burrows into the pod and lives in one of the seeds, the interior of which it entirely cleans out, leaving intact only the external thin brown skin. When full-fed it changes to the pupal state within this brown seed-skin, and this stage would appear to be a short one, as larvae are found in the seeds at the beginning of January. On maturing the beetle bores through the skin and the pod-covering and escapes. This exit-hole is usually made near the base of the seed-skin and near one edge of the pod-covering. I have never yet found more than one of these beetles in any one pod, although there are always several other holes in the pod, the work of other beetles, one of which may perhaps be the male insect. The beetles do not all mature and issue at once, as from pods sent me by Mr. G. M. Ryan and kept in Calcutta adults issued during the latter portion of February, all through March and April, and on into May.

The insect was found attacking tamarind seed in Calcutta in July 1891, by the Secretary of the Agri-Horticultural Society. The insect was in all stages of development (*Indian Museum Notes*, iii, 34).

In South Cuddapah the larva pupates towards the end of June or beginning of July. The larva here also lives entirely in the seeds of the tree.

In the mature state the beetles feed to some extent on the leaves of the host plant, and cause slight defoliation in this manner. In the Eastern Range in Vellore the beetles are said to damage casuarina by eating the needles. They have also been reported as infesting the seed of *Cassia muritura* in Cuddapah.

Relations to the Forest.

This insect belongs to a family of seed-eating beetles, and it is probable that a certain proportion of the seed of the *Bauhinia*, as well as that of *Cassia fistula*, *C. montana*, and *C. muritura*, is lost every year from its attacks. The more serious aspect of the case is that these beetles at times multiply to such an extent that they kill off the whole of the seed of the year. It is not unlikely that *C. gonagra* will be found to attack the seed of other trees, as it appears to have a wide distribution. I was able to identify the insect at the British Museum in 1904 with the valuable assistance of Mr. Gahan.

Tribolium castaneum.—This minute beetle, and its companion *T. confusum*, are often to be found plentifully in seeds infested by the *Caryoborus*. Its larva is probably predaceous upon the grubs of the bruchid (*vide* p. 239).

Caryoborus sp.

REFERENCE.—Stebbing, *Depart. Notes*, 367 (1906).

Habitat.—Bombay Presidency.

Tree Attacked.—Siris (*Albizzia lebbek*). Bombay Presidency.

Description.

Beetle.—Resembles the last in shape, but is greyish in colour; the elytra leave the last two segments of the body disclosed. The antennae are short, the thorax small and triangular, and the elytra greyish with longitudinal darker markings. The insect is of stout, thick build. The figure shows a dorsal and side view of the beetle.

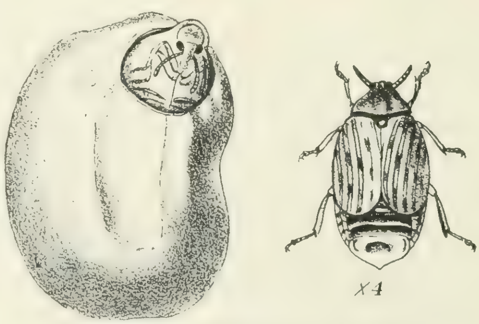


FIG. 177. *Caryoborus* sp. Bombay.

Life History.

The larva of this beetle feeds upon and destroys the seeds of *Albizzia lebbek*. These seeds are large, flat, and squarish, and are contained in a pod 9 in. to 12 in. in length. The grub completely hollows out the interior of the seed, leaving only the outer skin intact. When full-fed it pupates within the seed. Mr. G. M. Ryan, who forwarded specimens of this insect and the attacked pods, states that the damage done is very considerable. The figure shows a seed with a mature beetle half-emerged from it.

The beetle issues from the pods, which persist on the tree for a long time, in the hot weather about March and April in the Bombay Presidency, and evidently lays its eggs on or in the flowers or young forming pods in April and perhaps on through May. Only one grub is found within each seed. The pods mature about October, and the insect perhaps passes the cold-weather season as a pupa within the hollowed-out seed.

The siris-tree is very common all over India and Burma, and it is therefore necessary to ascertain whether this insect attacks the seed in this way all over the country.

Tribolium confusum (p. 238) is probably predaceous upon this bruchid.

Family CHRYSOMELIDAE.

(Leaf-eating Beetles.)

A very large family of brightly coloured, often metallic-looking beetles of moderate size, whose principal diet consists of the green parts of trees, shrubs, and plants. In addition to the damage done by the grubs the beetles themselves feed on leaves, often causing a considerable amount of defoliation to trees.

The family contains numerous forest species, and much remains to be learnt on the subject of the habits of the grubs.

Beetle.

To some extent the beetles resemble bruchids, but they have not the greatly thickened body and thickened hind legs of the latter family. The antennae are longer and are placed on the head away from the eyes. The head and thorax are comparatively narrow, the elytra much broader and varying considerably in shape. The head may be bent vertically downwards and the ventral sutures of the abdomen curved, but the members of the family vary in this respect, a number of divisions being based upon the differences.

Larva.

The larva varies greatly in shape and appearance according to whether it lives free on plants, mining in leaves or in roots or down in the soil at the roots, or again in cases or coverings made of various materials. According to its method of feeding, therefore, the larva may be an elongate whitish grub or a flattish grub protected by a covering of excrement which often gives it a greyish appearance, at times resembling a lichen.

The forest species known will be considered under the four divisions *Eupoda*, *Camptosomes*, *Cyclica*, and *Cryptostomes*, the third of which is by far the largest division of the family.

Classification.

Eupoda.—The head constricted between the eyes and produced anteriorly; prothorax much narrower at base than elytra.

Camptosomes.—Ventral abdominal sutures curved.

Cyclica.—Prothorax not much narrower at base than elytra, acute laterally.

Cryptostomes.—Head bent downwards, antennae inserted close together on head.

EUPODA.

Estigmena.

Estigmena chinensis, Hope.

References.—Hope, *Col. Man.* iii, p. 175, t. 2, f. 1; *Ind. Mus. Notes*, iii, no. 5, p. 80.

Habitat.—Berar, Madras, Lower Burma.

Trees Attacked.—Bamboo (*Dendrocalamus* sp. *strictus*?): Melghat Forest, Berar; *Dendrocalamus strictus*: Anaimalai Hills, South Coimbatore; *Cephalostachyum pergracile*: Kadin Bilin Forest, Tharrawaddy.


Fig. 178.
Estigmena chinensis, Hope.
Berar, Madras, Burma.

Description.

Beetle.—Elongate. Head and prothorax narrower than elytra. Head black, with some red tubercles on vertex. Prothorax chestnut, red-brown, or reddish yellow, shining. Elytra dark red or dark chestnut-brown or black. Antennae and tarsi black, rest of legs brown. Head with some prominent tubercles between the large black eyes; antennae long and heavy. Prothorax convex, with smooth, shining, irregular, elevate portions, the rest deeply pitted with larger coalescing punctures and depressions. Elytra rather flat, constricted at level of median coxae, thence widened to anterior fourth, and from there constricted on a regular curve; strongly and regularly striate-punctate, the interspaces smooth and shining. Under-surface rather flat, smooth, shining, dark brown, the abdominal segments very finely pitted. Legs stout and strong, with prominent tarsi. Length, 11.5 mm. to 16 mm. ♂ smaller than ♀.

Life History.

Considerable damage to bamboo shoots was reported by the Conservator of Forests, Berar, in November 1892. The insects responsible were identified in the Indian Museum, Calcutta, as the chrysomelid *Estigmena chinensis*. The damage done, as reported from observations made by the Forest Ranger from personal inspection in the forest, was to the tops of the shoots, the insect eating away the young succulent rolled-up leaves of the new shoots, thereby either arresting the growth or killing the stems. The destruction was done by the beetle itself.

At the end of July 1902 I found this insect fairly numerous on scrub-jungle consisting of the bamboo *Dendrocalamus strictus* in the Anaimalai Hills in South Coimbatore. The beetles were pairing at the time, and were engaged in feeding on the green shoots and leaves of the bamboo.

Whilst in the Tharrawaddy forests in Lower Burma in January 1905 I noticed numerous elongate holes in the young stems of the bamboo *Cephalostachyum pergracile*. Towards the end of the month a number of these stems were cut open, and some of the beetles of this insect were discovered inside. In no instance were beetles obtained from the stems of old bamboos. The investigations made show that the eggs are laid on the

young stems of the bamboo, and the grub tunnels right down the interior of the stem through the nodes.

One egg only is apparently laid on the stem between two nodes and near the upper one, and the grub tunnels down through the interior of the internode until it reaches the lower node, by which time it is full-fed and pupates. Under the operations of the grub the whole of the interior of the internode is eaten away. The beetle matures in the interior of the internode, and when fully developed it leaves by a hole in the stem which would appear to have been eaten out or partially eaten out by the larva. Towards the end of January I found the beetles mature in the interior of the internodes, and ready to leave the bamboo.

Although in some cases a young bamboo had been infested by several grubs, in no case did I find more than one beetle in any one internode, and it was fully apparent that only one grub had occupied the space between any two nodes.

It has been shown that the beetles appear in November in Berar and in July in Coimbatore. It is thus possible that there may be two generations of the insect in the year. This is, however, doubtful.

The insect must be looked upon as a serious pest of bamboos, since the beetle feeds upon the young shoots and leaves, whilst its grubs hollow out the interior of the stem.

It is the first instance I have met of a chrysomelid acting in this manner.

FIG. 179.—*Cephalostachyum pergracile* bamboos infested by *Estigmena chinensis*. A, beetle *in situ* in interior of bamboo; B, exit-hole of beetle in wall of bamboo near the upper node. (E. P. S.)

CRIOCERIS.

Crioceris impressa, Fabr.

REFERENCES. Fabr. *Mant. Ins.* i, 1787, p. 88; id. *Ent. Syst.* i, pt. 2, 1792, p. 6; Olivier, *Enc. Méth.* vi, 1791, p. 187; id. *Entom.* vi, 1808, p. 730, pl. 1, fig. 4; Lacord. *Mon. Phytoph.* i, 1845, p. 562; Baly, *Trans. Ent. Soc. Lond.* 1865, p. 32; var. *castanea*, Lacord. *Mon. Phytoph.* i, 1845, p. 564; var. *crassicornis*, Oliv. *Ent.* vi, 1808, p. 731, pl. 1, fig. 6; var. *omophloides*, Lacord. *Mon. Phytoph.* i, 1845, p. 564; Jacoby, *F.B.I.* Coleoptera, vol. ii, Chrysomelidae, p. 72.

Habitat.—The whole continent of India; Ceylon, Andaman Islands, Nicobars. Also Malayan Islands, Philippines, China, Siam.

Tree Attacked.—India-rubber (*Ficus elastica*). Charduar, Darrang, Assam.

Beetle.—Beneath, fulvous or piceous with silvery patches; thorax bluish or black; elytra fulvous or flavous. This is one of the most variable and widely distributed of all the species of the Chrysomelidae. Scarcely two specimens are ever alike, and

Description. this applies not only to coloration but also to sculpture. Some specimens are much narrower than others; the head is either fulvous or black, the antennae are sometimes much shorter than is the rule, also equally variable in

colour as the other parts; the punctation of the thorax is generally rather close over the middle of the disk; the elytral punctation is also variable, usually closest over base. The colour varies, being often a bright yellow. The general shape of insect is broad and robust; the thorax has rounded anterior angles, but sometimes these are furnished with a tubercle. Length, 7 mm. to 10 mm. (After Jacoby.)

FIG. 180.
Crioceris impressa, Fabr. India; Ceylon.

Life History.

I found specimens of this well-known chrysomelid in the rubber nursery at the Charduar Rubber Plantation in the Darrang Division in Assam. The beetles were either flying about in the hot sunshine or settled upon the young seedling plants and eating off the epidermis of the leaves of the rubber plants.

The beetles were chiefly noticed on 10 April 1906, on which date they were pairing.

CAMPTOSOMES.

Ventral abdominal sutures curved.

CRYPTOCEPHALUS.

Cryptocephalus pusaensis, Jacoby.

REFERENCES.—Jacoby, *Faun. Br. Ind.* Coleop. ii, Chrysomel. no. 374, p. 211 (1908); Lefroy, *Ind. Ins. Life*, 356 (1909).

Habitat.—Pusa, Bengal.

Tree Attacked.—*Tamarix gallica.* Pusa (Lefroy).

Beetle.—Testaceous; thorax with four more or less distinct black spots or bands surrounded by fulvous; elytra also with four or more small black markings placed on the punctured striae. Head strongly and rather remotely punctured, antennae black, short, extending to base of elytra. Prothorax twice as broad as long, strongly narrowed in front, middle of disk with two obscure piceous or dark fulvous longitudinal bands, more or less marked with black, sides with broader similarly coloured patch, marked with a black spot, rest of disk testaceous, extreme basal margin black. Scutellum oblong, apex truncate. Elytra sub-cylindrical, strongly punctate-striate, punctures deep and closely placed, partly transverse in shape, nearly black; shoulders with an irregular black elongate spot, another near the scutellum and two immediately behind the middle; these spots are often mere elongate short streaks. Length, 2.5 mm. (Description after Jacoby.)

Description.

Larva.—White, with the abdomen tapering and doubled back under the body so that the apex reaches the thoracic legs. The grub lives in a small oval case.

According to Lefroy, from whose specimens the species was described by Jacoby, the larvae are commonly found on the *Tamarix gallica* near Pusa and are easily reared.

CYCLICA.

Prothorax not much narrower at base than elytra, acute laterally.

Lina.

Lina populi, Linn.

Reference.—Linn. *Syst. Nat.* ed. x, p. 370.

Habitat.—North-West Himalaya.

Trees Attacked.—*Salix elegans:* Mahasu Ridge, Simla (J. H. Lace); *Salix babylonica:* Naini Tal (T. Carr).

Description.

Beetle.—Elongate-ovate. Head, prothorax, antennae, and legs brilliant metallic greenish-blue; elytra rather dull chrome-yellow; under-surface brilliant metallic blue. Head small, punctate, with a median depression, the antennae placed on lower outer edge. Prothorax wider than broad, anterior margin deeply concave, sides rounded, a longitudinal depression sloping outwards on either side of disk; latter moderately convex and finely punctate, punctures stronger on lateral edges. Elytra very convex, strongly and rather irregularly punctate, the punctures finer on the apical depression. Under-surface flat, very shining, the abdominal segments set with parallel, wavy, fine striae at rather wide intervals. Length, 11 mm. to 12 mm.

Fig. 181.
Lina populi, Linn.
North-West Himalaya.

Life History.

Specimens of this beetle were taken by Mr. J. H. Lace, C.I.E., Chief Conservator of Forests, feeding on the leaves of *Salix elegans* on the Mahasu Ridge near Simla in June 1901. I was present with Mr. Lace at the time, and the insect was found to be defoliating the trees. Only the mature beetle was taken.

On 10 May 1909 further specimens of the insect were forwarded to me by Mr. T. Carr, I.F.S. He found the beetle defoliating the *Salix babylonica* in Naini Tal. Only mature beetles were sent to me. No observations on the life history of the larva appear to have been made.

Chrysomela.

Fig. 182.
Chrysomela guttata,
Gebl. Kumaun.

Chrysomela guttata, Gebl.

Reference.—Gebl. *Mém. Mosc.* v, p. 310 (1817).

Habitat.—Kumaun, North India.

Tree Attacked.—Sál (*Shorea robusta*). Horai Forest, Kumaun.

Description.

Beetle. Elongate-ovate. Black, shining, with a yellowish-green metallic reflexion; antennae and legs with a strong violet reflexion. Head small, coarsely rugose-punctate. Prothorax nearly twice as wide as long, anterior edge emarginate, sides rounded; finely and irregularly punctate, the punctures strongest on lateral

edges. Elytra shining, convex, highly but irregularly punctate except for a series of roundish shining spots placed in five longitudinal rows, which consist of small areas, free of punctures, numbering some thirty in all. Under-surface flat, shining, with a violet reflexion, punctate, the abdominal segments with fine transverse striae. Length, 11.5 mm.

Life History. I took this chrysomelid on the leaves of the sál-trees in the Horai Forest in Kumaun on 15 April 1905. I found the beetles sitting on the leaves and adjacent twigs, but at the time they were not feeding on the leaves, though it is possible that they may do so.

Chrysomela ? sp.

Habitat.—Kumaun Terai, North India.

Tree Attacked.—Sissu (*Dalbergia sissoo*). Chorgallia, Kumaun.

Beetle.—Shining. Head, thorax, and antennae canary-yellow ; eyes black ; elytra dark blue-black. Under-surface and legs canary-yellow. Length, 9 mm.

Life History. I took several specimens of this beetle defoliating the sissu-tree in the river beds and elsewhere in the Terai forests of Kumaun in the first fortnight of April 1905. The beetle feeds on the leaves, eating out patches from the young new tender spring foliage.

GYNANDROPHTHALMA.

Gynandrophthalma sp. ?

Habitat.—Terai Forests, Kumaun.

Tree Attacked.—Sissu (*Dalbergia sissoo*). Chorgallia, Kumaun.

Beetle.—Elongate, elliptical. Head and thorax orange, shining ; elytra orange-brown ; eyes, greater part of suture, and sides of elytra medianly, black. Head depressed, with a median

Description. fovea between eyes. Prothorax triangular, narrowest in front, sides rounded, smooth and shining ; a median depression above scutellum. Scutellum large, triangular, finely punctate. Elytra wider than thorax at base, constricted at posterior coxae, thence widened, broadest in apical third, constricted and separately rounded at apex ; striate-punctate, the punctures moderately large and regular ; apical depression smooth, orange in colour. Under-surface darker-coloured. Legs orange, shining. Length, 3.8 mm.

This little beetle was taken in April 1905 feeding on the flowers of the sissu-tree in the Terai forests of Kumaun. The insect was not abundant.

PODONTIA.

Podontia 14-punctata, Linn.

REFERENCES.—Linn. *Syst. Nat.* ed. xii, p. 599; *I.M.N.* iv, 68 (1897).

Habitat.—Calcutta, Dehra Dun, Darrang, Assam. Also reported from Murshidabad, Sikkim, Shillong, and Andaman Islands.

Trees Attacked.—*Spondias mangiferae :* Calcutta (C. O. Bateman), Dehra Dun (*mihi*) ; *Ficus elastica :* Charduar, Assam.

FIG. 183.
Podontia 14-punctata. Linn. United Provinces, Bengal, Assam.

Description.

Beetle.—Oblong, thick-set. Head, prothorax, antennae, and legs shining; eyes canary-yellow, and mouth parts black; elytra a bright salmon-pink in colour, each with eight spots, the upper and lower ones of which coalesce when the elytra are closed, and thus give fourteen spots. Beneath the basal median spot is a large round or square one on each elytron, another large one beneath this, and then the large apical one. On the outer margin of each elytron are four smaller spots placed more or less equidistantly from one another. These spots sometimes coalesce to form transverse bands. Under-surface of abdomen canary-yellow, darker on thoracic region. Length, 13 mm. to 17 mm.; breadth, 7 mm. to 8.6 mm.

Larva.—Dirty yellow or yellow-brown, the body thick and corrugated. The grub is thick, soft, and fleshy, and has a black shining head, a black patch on dorsal side of prothorax, and three pairs of black shining legs. Length, 16 mm. The larva covers its body with its own excrement, and so has the appearance of the droppings of a bird, and is thus able to escape the attacks of foes.

Cocoon and Pupa.—The grub pupates in a coarse earthen cocoon in the soil. This cocoon resembles in size and shape a hazel-nut.

Life History.

In October 1895 Mr. C. O. Bateman of the Indian Museum, Calcutta, presented specimens of this insect in all stages of larva, pupa, and imago to the museum, with the information that the insect stripped the leaves from a *Spondias mangiferae* tree in his compound in Calcutta. Mr. Bateman stated that the beetles appeared almost every year when the tree was in full foliage in July and August, and disappeared in October. The injury done is confined to the leaves, which are consumed, the trees being often rendered leafless.

Investigations have been made into the life history of the insect in Dehra Dun. Here the beetle and its grubs also attack the *Spondias mangiferae*. I first noticed this attack on a tree in September 1902. The insects commenced work in the first week of the month, and by the 23rd the tree was entirely leafless. So numerous were the insects towards the end of the period that they looked like brightly coloured fruits on the branches.

Nearly every year between 1904 and 1909 I noted this attack in the station, and a particular tree was either partially or entirely defoliated each year by the beetles.

As has been already pointed out, the larva is a most curious and interesting subject for study, owing to the wonderful methods of self-protection it has adopted. In many cases it is almost impossible to distinguish the grub upon a branch from the excrement of a bird so long as it keeps still. The beetle when disturbed or alarmed feigns death and keeps quiet for a considerable period.

In the year 1906 I found this insect on the wing in April in the Charduar Rubber Plantation in the Darrang Division in Assam. I first noticed the insect in some numbers in several compartments of the

plantation on 5 April. Two days later I found a tree almost entirely defoliated by the beetles, who were in hundreds upon it. Hard by two other trees had been completely stripped. Some of the beetles were coupling. I could find no larvae on the trees.

The fact that the beetle appears in the adult stage as early as the first week in April in Assam points to the possibility of there being two broods of the insect in the year in the hot and damper parts of its habitat.

Relations to the Forest.

This chrysomelid must be looked upon as a dangerous defoliating pest in the forest, and more especially in areas of young growth. The insect (both grub and beetle) is of considerable size and coarse, heavy build, and strips the trees of foliage and the green cortex from the younger branches in a ruthless manner which cannot but seriously affect the growth of the plants subjected to the treatment.

Treatment.

We know that the insect pupates in the soil, and the only possible method of combating a serious attack would be to endeavour to kill off the insects whilst in the cocoon in the soil. In the case of serious infestations over considerable areas in valuable plantations and forests I should recommend the judicious use of fire as the only effective means of dealing with the insect.

Blepharida.

Blepharida hirsuta, Jac.

Fig. 184.
Blepharida hirsuta, Jac. Poona.

Habitat.—Poona, Bombay.

Tree Attacked.—*Boswellia serrata.* Bhamburda Reserve, Poona.

Description.

Beetle.— Elongate - elliptical. Pale canary - yellow, the elytra and femora of hind legs darker and mottled with brownish markings. Head with vertex smooth and front covered with a fine silvery pubescence. Prothorax flat, wider than long, anterior edge straight, sides rounded ; a small depression on either side of disk almost glabrous, with a very fine and short silvery pubescence. Elytra elongate, constricted to apex, moderately convex, strongly striate-punctate. Under-surface yellowish brown, clothed with a fine short silvery pubescence. Femora of hind legs much thickened, the legs rather long. Length, 12 mm.

Life History.

In company with Mr. R. Wroughton, formerly Inspector - General of Forests, I took several specimens of this weevil defoliating the *Boswellia serrata* in the Bhamburda Reserve near Poona on 2 August 1901. The insect was in company with the *Haltica*? sp. described below, the latter being by far the more numerous of the two present. A serious amount of defoliation had taken place under the attacks of the beetles.

Ophrida marmorea, Wiedem.

REFERENCE.—Wiedem. *Zool. Mag.* i, 2, p. 181 (1819).

Habitat.—Rangoon Forests, Lower Burma.

Tree Attacked—*Holarrhina antidysenterica.* Magayi Forest, Rangoon Division.

Beetle.—Elongate-elliptical, shining. Head and prothorax and legs red-brown ; elytra dark red-brown, mottled with light yellower patches. Front of head tuberculate, dull, very finely punctate. Prothorax rather flat, wider than long, anterior edge concave, sides rounded with a constriction medianly ; disk surrounded by a heart-shaped depression ; a few scattered rather large punctures on basal area. Elytra convex, depressed apically, the sides constricted to apex ; strongly punctate-striate. Under-surface dark red-brown, shining, finely punctate ; femora of hind legs thickened. Length, 12.5 mm.

Description.

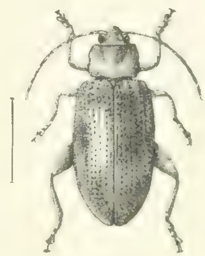


FIG. 185.

Ophrida marmorea, Wiedem. Lower Burma.

This chrysomelid does a certain amount of defoliation in the beetle stage. I found the insect feeding on the leaves of *Holarrhina antidysenterica* in the Magayi Forest of the Rangoon Reserves on 8 February 1905. The tree formed the lower story of the forest growth, and in the case of trees here and there a considerable percentage of the leaves had been partially eaten by the beetle.

Life History.

HALTICA.

Haltica ? sp.

REFERENCE.—This beetle was identified at the British Museum as doubtfully a species of *Haltica ;* Stebbing, *Depart. Notes*, i, 179 (1903).

Habitat.—Bombay Presidency.

Tree Attacked.—*Boswellia serrata.* Bhamburda Reserve, Poona.

Beetle.—A medium-sized thick-set insect with small yellow head and two prominent black eyes. Thorax yellow, slightly broader than long, small. Elytra broader than thorax, yellow to brownish in colour, the yellow being generally in irregularly shaped faint blotches. At times a few faintly marked black spots are present. In the ♀ the elytra are sometimes all yellow with scattered brownish markings and small spots. The elytra are broadly striated with rows of punctures between the striae, and are deflexed posteriorly, leaving one segment of the body exposed. The body is thick and pointed posteriorly, yellow to yellow-brown beneath, and shining. Antennae and legs canary-yellow, the former being slender and short. Posterior pair of legs are long and have their femora remarkably thickened and developed, thus enabling the insect to leap the great distances it is capable of doing. These femora are at times dark yellow to brown in colour. The posterior tibiae are spined at their bases. The third tarsal joint is deeply bilobed.

Description.

Length, ♂ $\frac{3}{16}$ in. : ♀ $\frac{1}{4}$ in. Pl. viii, fig. 4, in *Depart. Notes* shows a dorsal and side view of this chrysomelid.

This beetle appears on the wing at the beginning of August, and possibly during the latter part of July.

Life History. It feeds upon the leaves of *Boswellia serrata*. These leaves are compound ones, and it apparently attacks the upper leaflets first, feeding downwards until about two-thirds of the compound leaf (from top downwards) has been more or less eaten away. At other times all the leaflets disappear entirely. The beetle begins by eating the leaflet irregularly round the edge, patches being gnawed out, or it commences on the inner part and eats out holes in the leaf tissue. The effect of this defoliation is to cause the leaflets to shrivel up, turn brown, and fall off.

At the beginning of August, when these beetles were observed at work, the insects were pairing; the male, the smaller insect of the two, being carried about on the back of the female. This chrysomelid is a powerful jumper, and even when coupled the ♀ will often take a long leap. Like many Chrysomelidae the beetles are extremely wary, and take to flight at the slightest motion which alarms them. If too late to fly, they drop off the food-plant like a stone and sham death on the ground, where owing to a similitude in colouring they are extremely difficult to see. When coupled, they appear to lose some of their extreme wariness.

Relations to the Forest. I have described above the manner of feeding of this chrysomelid. There can be no doubt that when in any numbers it is capable of doing a large amount of defoliating damage. We do not yet know where its larval stage is passed or upon what the grub feeds.

Clitea.

Clitea picta, Baly.

Reference.—Baly. *Trans. Ent. Soc.* p. 287 (1877).

Habitat.—Bengal, North India.

Tree Attacked.—Bael (*Aegle marmelos*). Bengal (Lefroy); North India (*mihi*).

Beetle.—Small, oval in shape; black and brown in colour.

Larva.—Soft, whitish, with a few very short hairs; the head brown, the tiny round spiracles on the dorso-lateral line. Behind the head is a distinct prothoracic shield, and over the anus is a flat black plate with short hairs round; this plate is at an angle to the long axis of the body, facing dorsally and posteriorly, and may be for the purpose of enabling the larva to exert pressure by placing this against the wall of the tunnel. (Description after Lefroy.)

Life History. This is a common small chrysomelid found on the bael-tree (*Aegle marmelos*), whose leaves the beetle defoliates by eating patches out of them. The beetle jumps actively when disturbed. I have not taken the larva myself. Lefroy, in *Indian Insect Life*, has the following account of its habits: "The larva is found boring in the shoots of this plant" (i.e., the bael), "the slender twigs being tunnelled down the centre, but little harm being done."

LUPEROMORPHA.

Luperomorpha weisi, Jacoby.

REFERENCES.—Jacoby, *Ann. Soc. Ent. Belg.* xlii, 180 (1898); *Ind. Mus. Notes*, v, 125.

Habitat.—Chota Nagpur.

Tree Attacked.—Mango (*Mangifera indica*). Purulia, Chota Nagpur.

Description.

Beetle.—Small, shining. Chocolate brown, prothorax orange; antennae chocolate, femora of hind legs chocolate brown, rest of legs yellow, tarsi darker-coloured. Head vertical, eyes large, placed at sides, antennae long, slender, inserted in front, at some distance from each other, and reaching to slightly below middle of elytra. Prothorax wider than long, sides rounded; disk smooth, shining, and very finely punctate. Elytra impressed basally, smooth, glabrous, finely punctate. Under-surface of abdomen yellow.

Life History.

This beetle was first reported from Ranchi in Chota Nagpur, and proved new to science. In August 1900 it was again sent to the Indian Museum, this time by Mr. W. H. P. Driver. Mr. Driver reported that the chrysomelid was destroying all his mango-trees.

MIMASTRA.

Mimastra cyanea, Hope.

REFERENCES.—Hope, Gray, *Zool. Misc.* 1830; *Ann. Soc. Ent. Belg.* lxxxiii (1890).

Habitat.—Dehra Dun, North India.

Tree Attacked.—*Grewia asiatica*. Dehra Dun (Rogers).

Beetle.—This small beetle is yellow in colour, shining, with filiform antennae about three-quarters the length of the body. The head is small, round, and separate from the prothorax. Prothorax quadrangular, slightly longer than broad. Elytra oblong-oval, dilated behind and very obtuse. Legs longish. Length, 9 mm.

Life History.

The beetle appears on the wing about the middle of June or perhaps earlier, it having been found by Mr. C. G. Rogers, Deputy Conservator of Forests, defoliating trees on the 18th of the month. Neither larva nor pupa appears to have been noted, and no further observations on its life history are forthcoming as regards the dates of the larval and pupal stages and the number of generations in the year.

Relations to the Forest.

This beetle was reported from the Dehra Dun district in 1896. *M. cyanea* defoliates both young and old trees of the species *Grewia asiatica*. In the attack noticed in 1896 the beetles were said to have appeared in large numbers, flying freely and being sufficiently numerous to produce a humming noise as of a swarm of bees passing overhead. The majority of the leaves were badly eaten by 18 June, in many cases only a short piece of the base of the midrib remaining intact. No birds were present feeding upon these beetles,

and it is probable, as noted by Mr. Rogers, that the thick orange liquid which they have the power of emitting from their heads has some distasteful quality in its composition.

Protection and Remedies.

These leaf-feeding beetles are best attacked by one of the arsenical solutions sprayed over the plants to be protected, and this spraying should be done either in the very early morning or late in the evening. The beetles feeding upon the leaves take the poison internally, and are thus killed off.

More facts about the life history, such as where the eggs are laid, where the larvae feed, etc., are required to be known before one can state definitely how such pests can be best attacked.

Melasoma.

Melasoma sp. prox. **populi**, Linn.

References.—*Ind. Mus. Notes*, iii, no. 5, p. 43; Rogers, *Ind. For.* vol. xxii, 429.

Habitat.—North-West Himalaya.

Tree Attacked.—Willow (*Salix elegans*). Deoban, Jaunsar (C. G. Rogers).

Beetle.—I have not seen this beetle.

Larva.—Head black, body yellowish white, with black markings; the dorsal surface furnished with numerous paired glands. Length, 0.10 in. to 0.51 in. (C. G. Rogers.)

Pupa.—The pupa has not the same general markings as the larva. It remains partially enclosed within the larval skin. It is suspended from the under-surface of the leaves and branches of the tree. (C. G. Rogers.)

Life History.

The damage done by this insect to willow in the Western Himalaya was first reported by Mr. C. G. Rogers. The following details on the life history are from a note drawn up by him and published in the *Indian Forester*: "The larvae were first noticed on 9 June 1893 in Deoban, elevation 9,000 ft. From the paired glands on the back of the larvae little transparent globules of strong pungent-smelling fluid exuded when the insect was touched. After a while the globules were drawn in again into the glands, but could be again extruded two or three times before the insect became exhausted. The odour, which is compared to prussic acid, scented the whole bush where they were feeding, and was a very characteristic feature of the insect. Larvae which were kept in captivity moulted once before pupating. Pupae were found between 14 and 21 June. On the plant the larva suspends itself from a twig or under-side of a leaf before pupating. Beetles began to emerge on 22 June, and continued to appear in the rearing-box till 27 June. They afterwards lived for about a week in confinement, but as in this period they were carried down to Dehra Dun (elevation 2,100 ft.), their ordinary period of existence in this stage is likely to be much longer."

The larvae were feeding upon the willow-leaves. On several occasions I have found the larvae upon this willow in Jaunsar, and I have been able to corroborate Mr. Rogers's observations.

Mascicera ? sp.—Out of fifty-one larvae and pupae six were found to be parasitized by a dipterous grub. This grub pupates inside the body of the chrysomelid larva. From the dipterous pupae flies emerged on 30 July. The specimens sent to the Indian Museum were, however, said to be in too poor a state of preservation for identification. It was thought that they were possibly species of the well-known parasitic genus *Mascicera*.

Parasitic Insect.

It is an observation of high value that Mr. Rogers should have bred out the fly from its host.

CRYPTOSTOMES.

Head bent downwards; antennae inserted close together on head.

Platypria.

Platypria andrewesi, Ws.

References.—Ws. *Deutsche Ent. Zeitschr.* p. 404 (1906); Lefroy, *Ind. Ins. Life*, 364 (1909).

Habitat.—Plains of India.

Tree Attacked.—Ber (*Zizyphus jujuba*). Pusa? (Lefroy).

Beetle.—A broad squarish beetle; the sides of the prothorax and elytra produced into processes of varying length, the apical edges of the elytra being serrate. The elytra are very broad, with a series of longitudinal parallel ridges elevated at points into sharp teeth.

Larva.—"Flat, the head large and hard, with short antennae and a lateral cluster of ocelli; the prothorax bears a dorsal and a ventral shield; the segments are produced laterally and bear a terminal backwardly-curved process; the spiracles are on the dorsum; the legs are well developed, and the larva runs actively; the abdomen terminates in a flat chitinous plate with a lateral process, the anus being ventral. It pupates in a special pocket in the leaf."

Pupa.—"The pupa is similar, but the fourth abdominal segment is drawn out laterally into a strong backwardly-directed process on the dorsum." (Description after Lefroy.)

Life History.

This is one of the leaf-mining Chrysomelidae, the egg being laid in the tissues of the leaf and the grub mining in the leaf parenchyma. In the case of this insect, according to Lefroy, the larva "does not remain in one mine, but moves about, eating into the leaf, eating out a kind of pocket, and then emerging to commence a fresh pocket."

Platypria ? sp.

Habitat.—North-West Himalaya.

Tree Attacked.—Kharshu Oak (*Quercus semicarpifolia*). Deota Forest, Tehri Garhwal; Deoban, Jaunsar.

Description. **Beetle.**—Head dark orange-yellow, shining; antennae long and black; eyes black. Prothorax canary-yellow, shining. Elytra metallic green. Segments of the abdomen beneath the same colour, the head and thorax beneath being yellow. Legs black, except coxa, trochanter, and femora, which are canary-yellow. Third tarsal joint with a yellow pad or brush beneath; claws short. Length, 15 mm.

Life History. This is a somewhat large chrysomelid, which defoliates the Kharshu oak to some extent in the beetle stage. I first took the beetle engaged in this manner above Deota at about 8,000 ft., at the end of June 1902. On 9 July I again took the insect engaged in the same way at Deoban in Jaunsar, elevation 9,300 ft.

Pseudocolaspis.

Pseudocolaspis indica, Baly.

Reference.—Baly. *Jour. Linn. Soc.* xiv, p. 249 (1877).

Habitat.—North-West Himalaya.

Tree Attacked.—Sweet Chestnut (*Castanea vesca*). Nachar, Bashahr State.

Beetle.—Bright metallic green tinged with indigo. Antennae orange-yellow. The trochanter and femora of legs blue-green, tibiae and tarsi yellow. Length, 4.5 mm.

Life History. I found this beetle in large numbers on 22 June 1901, feeding on the inflorescences of the sweet chestnut in the compound of the Nachar bungalow on the Himalayan-Tibet road in Bashahr. The inflorescences were being totally destroyed under the attack of this small beetle.

Calopepla.

Calopepla leayana, Latr.

References.—Latr. *Gen. Crust. et Ins.* iii, p. 50, pl. 11, fig. 7; *Ind. Mus. Notes*, iii, no. 5, p. 80.

Habitat.—Poona.

Tree Attacked.—Shiran Tree (*Gmelina arborea*). Poona (Gleadow).

Beetle.—Black, with red markings.

Life History. This insect is to be found on the wing in September in Poona. In that month in 1893 it was reported by Mr. F. Gleadow, of the Indian Forest Service, as defoliating the *Gmelina arborea*, cutting large and unsightly holes in the leaves. The insect was identified in the Indian Museum.

Aspidomorpha.

Aspidomorpha sanctaecrucis, Fabr.

Reference.—Fabr. *Ent. Syst.* iv, App. p. 446.

Habitat.—Tharrawaddy, Lower Burma.

Tree Attacked.—Teak (*Tectona grandis*). Kadin Bilin Forest, Tharrawaddy.

Description.

Beetle.—Brightly coloured spherical-ovate, resembling in shape a tortoise-shell. Upper outer surface shining yellow, with the median portions, consisting of the "body," "head," and "legs," brilliant coppery. Antennae yellow with a black club. Legs canary-yellow. Length, 10 mm. to 12 mm.

Fig. 186. *Aspidomorpha sanctaecrucis*, Fabr. Lower Burma.

Life History.

I took some specimens of this beetle on teak leaves in the Kadin Bilin Forest on 23 January 1905. The insects were defoliating to a slight extent the teak leaves of the saplings in a 1902 tounggya teak plantation, but the damage was slight and the insect not abundant.

The beetle is a very handsome and easily recognizable object in the brilliant sunlight. The insect lives for a considerable period without food in the adult stage. I kept beetles taken on 23 January in a box without food, and they were still alive and active on 22 February following.

CHAPTER XV.

PHYTOPHAGA (*continued*)—Family CERAMBYCIDAE.

(*Longicorn or Long-horned Beetles.*)

THE longicorn or long-horned beetles as they are often termed, owing to the pair of long, prominent, jointed antennae which adorn the head, are probably the members of the Coleoptera best known to the Forest Officer. Not that they are to be found commonly on the wing in the daytime, for this is not usually the case, although, as we shall see, there are some diurnal forest-living species, such as, e.g., *Thysia wallichii;* nor because they are brilliantly coloured, for dull browns, greys, and blacks predominate in the family. The insects will be known owing to the fact that they are often found in tunnels inside timber—that, indeed, timber is often ruined or disfigured in the forest by tunnels which, in a general way, the Forest Officer attributes to the operations of these insects; and he is very often correct in his surmises, although in many instances he may be unacquainted with the pest itself, either in the larval or beetle stage. Another manner in which these insects—many of which are of bulky and massive form and lumbering flight when in the neighbourhood of light—bring themselves into prominence, is by entering the bungalow at night. Information of considerable importance to the forester can be gained by their nocturnal visitations; for their appearance means that the insect is at that period egg-laying in the forest, and for this purpose is searching for newly felled unbarked trees, or for sickly, perhaps dying, standing ones. We thus, by noting these dates of appearance, secure firstly the date of appearance of the insect on the wing, or one of the dates should the beetle pass through more than one life-cycle in the year; secondly, the date, or approximate date, on which eggs are laid in the trees, since but a short period is usually passed by these insects in the perfect, or imago, state; thirdly, the date, or approximate date, on which the young grubs or larvae hatch out from the eggs, observation having shown that but a short period is passed in the egg stage by many of the forest-living members of the family, often forty-eight to sixty hours only.

The life histories of many of the forest-living Cerambycidae are of considerable interest, and in nothing, perhaps, are the beetles so remarkable as in the possession of an instinct which enables them to seek out newly felled or sickly or dying trees. Nothing is more striking than the undoubted possession of this wonderful power or instinct by the beetle *Hoplocerambyx*

spinicornis. Green sál-trees in Goalpara, Assam, felled one day, were found the next to have a hundred or two of the beetles crawling about in the shade of the outside of the bark nearest the ground, all intent on pairing or egg-laying. The forest contained hundreds and thousands of these beetles, and yet there was no sign of them until sought for, as the insect is not a diurnal one, as is the case with its companion in these forests, *Thysia wallichii*, which is found at the same time flying about or sitting on the bark of the trees in the sunlight.

The larger forms of this family have a powerful flight, and they will be found on the wing at night apparently very little incommoded by the severest of spring storms.

Beetle.

Briefly, as will be seen by a reference to fig. 187, the beetle is of elongate form, with well-marked "shoulders" to the elytra, a prominent prothorax, and a vertical or horizontal head. The antennae are very characteristic of the insects, having eleven (sometimes twelve) joints each, usually long, the basal one swollen, and the others tumid at the nodes. These antennae are held over the back in the position of rest; the basal joint fits into the eye on one side, the latter being hollowed out to take this insertion, and becoming thus reniform, or kidney-shaped. It will be usually found that the antennae are longer in the male than in the female. The mandibles are long and powerful, and the palps prominent. The thorax is usually square, and may be spined, and is at times corrugated on the dorsal surface. The legs are strong and long; the tarsus of the foot is four-jointed, the first three joints being bilobed, and spongy and hairy. The elytra are flat, and the beetles of all sorts of colours, but rarely metallic (as in the case of the Buprestidae). They are

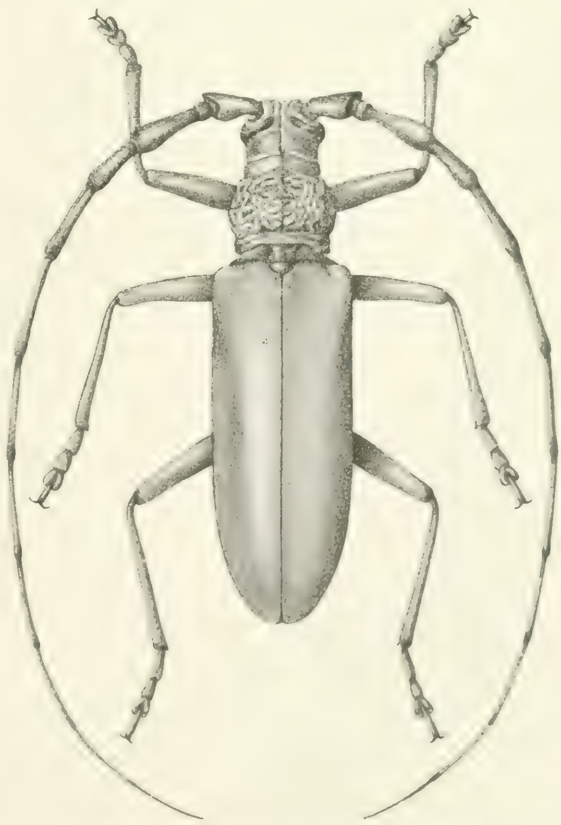


FIG. 187.—*Massicus unicolor*, Gahan. ♂ $\frac{1}{1}$.
Southern Shan States.

at times covered with hair, the pubescence being often silky, and giving silvery reflections under the play of light; or the hair may be in tufts on them, with often additional tufts on the antennae, as in the case of the brightly coloured diurnal *Thysia wallichii* (fig. 17). The female, in addition to having shorter antennae than the male, has at times the pygidium exposed below the apices of the elytra, and has a strong non-extruded ovipositor for egg-laying, the egg being often put into deep crevices in the bark by means of this instrument (cf. figs. 28, 29).

Larva.

The larva (fig. 30, *c*) is a stout, elongate, segmented, practically legless grub when full-grown, as shown in fig. 30, *e*, and is usually white, or yellowish white, or pale orange in colour; the segments taper only slightly from the anterior end downwards. Those we shall consider here are all wood-feeders, and have powerful black biting jaws or mandibles, with which they are capable of tunnelling down into the hardest timber. The grubs have short, four-jointed antennae, and may have very short legs in some cases. The upper surface of the head and of the thoracic segments is covered with a hard, horny plate; the segments of the body have often tubercles on them, and the spiracles on the sides of the segments are well marked.

The grubs spend their lives burrowing either in the bast and sapwood, into the sapwood, or down into the heart-wood of trees, making galleries in the latter which have a more or less square section. They may live for one or more years feeding in this manner, or they may spend only a few months or weeks in this stage of their lives. Before they change to the pupal state they usually enlarge the end of their tunnel, and this enlargement may be made in the bast layer in the sapwood, or the grub may bore down into the heart-wood with the sole object of placing the pupal chamber there. This latter procedure, as we shall see, is undertaken by several of our worst cerambycid pests.

Pupa.

The pupal stage is the resting stage, and during this period the insect gradually changes from the larval to the perfect or beetle stage. The grub gradually takes on the appearance of the beetle, and when the pupa is fully formed we can see in it the shape of the future beetle with the antennae, legs, and wings pressed close down the sides and against the chest, all the parts being free and unenclosed in any silk covering or cocoon (fig. 31, *c*). In fact, the pupa usually lies quite naked in the pupal chamber at the end of the larval tunnel. In rare cases, of which we have a curious example in India in the beetle *Plocaederus obesus*, Gahan, the larva constructs a calcareous cocoon resembling a pigeon's egg, in which it transforms to the beetle state (see fig. 206).

The actual change from the grub to the pupa would not seem to last, in the case of the Indian forest Cerambycidae, for more than a few weeks, and an examination of the pupal chamber will then disclose the fully formed beetle with all its parts perfect. A superficial inspection will show that

the colouring is still imperfect, the shades being probably light yellow or brown, and a close examination will disclose the fact that the outer parts are still rather soft and that the insect is only able to walk in a tottering manner and is quite unable to fly. This resting stage of what appears to be the perfect insect is common to most bark- and wood-boring beetles, and the rest is undertaken with the sole object of allowing the thick and very hard outer covering of chitin to consolidate and dry. A knowledge that such a stage is passed through is of considerable importance for two reasons. Firstly, several instances have come to light where the discovery of beetles in this stage has been recorded, and quite wrongly recorded, as the date of appearance on the wing of the insect in question, and with that emergence have followed incorrect inferences of the periods of oviposition and hatching out of the larva. Observations in the forest have led to the discovery that these apparently correct dates of appearance of the beetle were solely based on the fact of the beetles having been found in the resting stage *in* the trees, the knowledge that the beetles would have remained in such a position for another two or three months having been lacking.

I shall have occasion to allude to one or two such records having led to confusion in drawing up the life histories of the insects in question.

The insects I propose to deal with here will be treated of in the order of their at present accepted scientific position in the family as given in Gahan's volume in *The Fauna of British India*. I would not have it understood that we know at present anything like a tithe of our Forest Cerambycidae. We do now know, however, some of the most important of the pests of the family with which the forester has to deal, and their description here will, it is trusted, lead to a fuller knowledge of the family.

Habits of and Damage done by the Family.

The bulk of the Cerambycidae are probably forest-living insects, and this is almost certainly the case with the larger members of the family. As a general rule the insect lays its eggs in crevices of the outer bark as near to the bast layer as possible, or, when occasions serve, at the edge of some wound in the bark. This latter is commonly the case with the poplar and willow longicorn, *Æolesthes sarta*.

The young grub on hatching bores down into the bast layer and eats out a small tunnel parallel to the long axis of the tree. As it grows in size this tunnel becomes broader and deeper in extent, and when the mandibles are sufficiently powerful it grooves down into the sapwood. For some months the grub continues to carry this tunnel onwards in the bast and sapwood, curving about to a certain extent, but usually keeping a more or less up-and-down direction parallel to the long axis. With the increase in size and strength of the grub the tunnel becomes very broad, two to four times the breadth of the grub itself, the latter entirely removing all the green bast from the bark and grooving deep into the sapwood. It thus becomes obvious that when the grubs are in numbers in a tree

they may entirely remove all the bast, on which they feed, round a section, or even in course of time from the whole of the stem of a tree, which thus becomes completely girdled and dies. When such an attack is in progress, if the outer dead bark be removed a mass of wood, sawdust, and larval excreta will be found blocking these galleries, consisting of the undigested residue of the bast and sapwood consumed by the grub, which it ejects, and leaves blocking its gallery behind it as it tunnels onwards in the tree. When such a mass is found beneath the bark of a dying or dead tree it forms an evidence of the former and present presence of longicorn beetles in the tree. Externally the tree itself shows by its sickly appearance and the falling of its needles or leaves that it is suffering from some attack which is killing it. Noteworthy examples of such attacks actually observed and reported, although the aggressor was still unknown, were the great longicorn (*Æolesthes sarta*) attack which decimated the poplar and willow avenues on the roads in Quetta, reported in 1904 by Col. A.

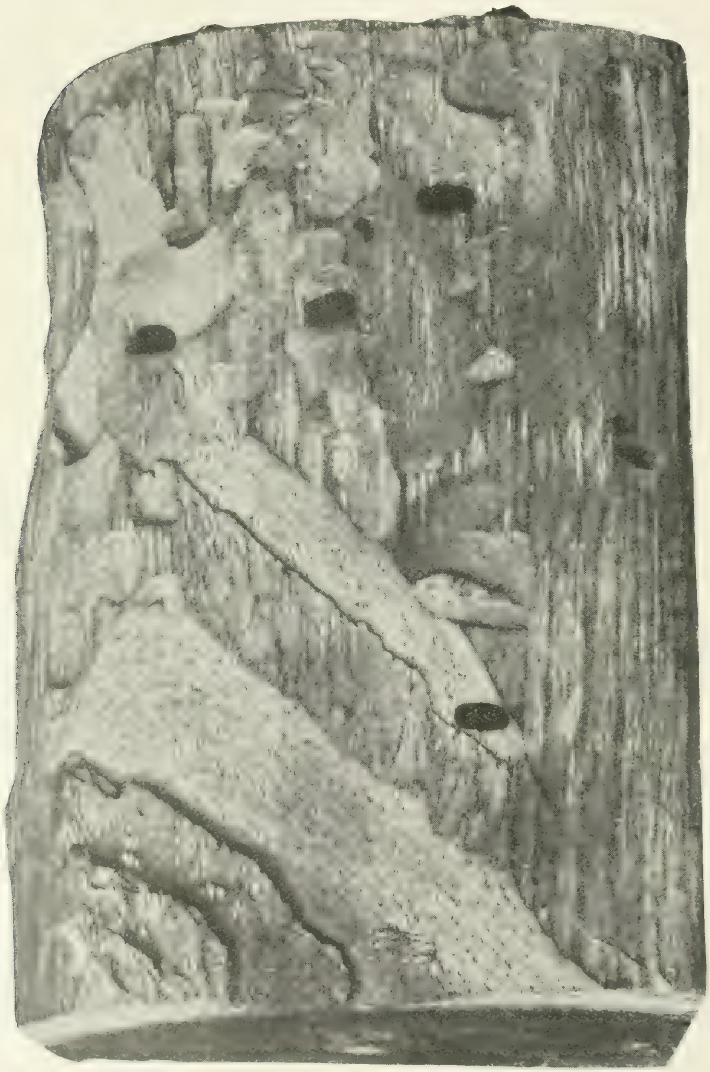


FIG. 188.—Section of a stem showing large flat galleries eaten out in the sapwood by cerambycid grubs and the entrance-holes to the pupating-chambers in the wood.

Archer, C.I.E., the attack of the longicorn *Hoplocerambyx spinicornis* in the sál forests of Goalpara, reported by Mr. W. F. Perrée, I.F.S., in 1905, and the attack of the longicorn *Æolesthes holosericea* in a block of the sál forests of the United Provinces Terai, reported by Mr. R. Milward in 1908.

When full-fed the longicorn grub tunnels further into the sapwood for an inch as in the case of the deodar *Trinophyllum*, or may go right down into the heart-wood, as in the case of *Æolesthes sarta* and *Hoplocerambyx spinicornis*, to pupate. In the first instance, after making a tunnel of about an inch down in the sapwood the grub eats out a slightly broader elongate chamber parallel to the long axis of the tree and pupates in this. The tunnel in the sapwood and the pupal chamber are both kept entirely free of wood particles and excreta, all of which are ejected from them (cf. pl. xviii and fig. 237).

In the case of the grubs who go right into the heart-wood the tunnels are eaten out to a varying depth. When the grub is satisfied that it is deep enough it also turns and eats out a wider elongate chamber parallel to the long axis of the tree, and, turning round so as to face upwards, the grub pupates here (cf. pl. iv and fig. 25).

The damage done to the tree by both these kinds of grubs is the same so far as the growth of the tree is concerned. The green bast layer is removed by the larvae, and when they are numerous the tree dies. In the case of the grubs who go right down into the heart-wood the injury is even more serious, as the timber itself is also ruined owing to the numerous tunnels penetrating into the heart-wood in all directions. This is one of the gravest features of the attacks of some of the larger longicorns, such as, for instance, the well-known sál cerambycid *Hoplocerambyx spinicornis*, which is rightly dreaded in the Assam sál forests, where it works with amazing rapidity and destructiveness.

Gahan in the *Fauna* divides the family into two sections, the Cerambycinae and the Lamiinae, which may be distinguished by the following characters :—

Classification.

Cerambycinae.—Head in front oblique or sub-vertical, last joint of palpi not pointed at the end; fore tibiae not grooved beneath.

Lamiinae.—Head in front vertical or bent inwards well below the thorax; last joint of palpi pointed at the end; fore tibiae generally with a groove beneath.

CERAMBYCINAE.

This group contains some of the most important of the longicorn pests of the forests. As a general rule the larvae feed in the bast and sapwood of the tree, eating out ramifying tunnels here. They only penetrate deeper into the sapwood to pupate. Genera of importance in the forests are known in three of the four sub-families into which Gahan divides the Cerambycinae, namely, Prionini, Disteniini, Lepturini, and Cerambycini.

No species of the Disteniini have yet been discovered as of forest importance.

Sub-Family I.—PRIONINI.

Fairly easily distinguishable by the fact that the prothorax is marginate at the sides; the front coxae are strongly transverse.

Lophosternus.

Only one species of this genus is at present known to infest forest trees.

Lophosternus hugelii, Redtenb.

(The Oak Timber Longicorn Borer.)

References.—Redtenb. *(Cyrtognathus) Hugel's Kaschmir*, iv, 2, p. 550, pl. 28, fig. 1 (1848); Gahan, *F.B.I.* Coleopt. vol. i, Ceramb. no. 8, p. 11 (1906); Stebbing, Insect Pests Himal. Oak, *Ind. For. Rec.* vol. ii, pt. i (1909).

Habitat.—North-West Himalaya Oak Forests. Gahan in *Fauna* gives Kashmir, North-West Provinces, Punjab, Assam.

Trees Attacked.—Ban Oak (*Quercus incana*). Probably also the Moru Oak (*Quercus dilatata*).

Description.

Beetle.—♂ The beetle is chestnut-red in colour, the head and prothorax darker than elytra, at times the thorax being almost black. Head closely punctured; the last joint of the palpi distinctly widened towards the extremity. Eyes large and placed rather close to the insertion of the antennae behind. Antennae a little shorter than body, the first joint not reaching beyond the hind margin of the eye, third to tenth joints acutely produced at the apex on the anterior side. The prothorax is finely and closely punctured in front and along sides, smooth and shining medianly, the hind angles obtuse and projecting, and the side margins produced outwards into two sharp points; elytra rugulose, the ridges finely punctured, and each with two or three weak raised costae. The hind breast beneath covered with a tawny-coloured silky pubescence. The last ventral segment is sinuate at the apex.

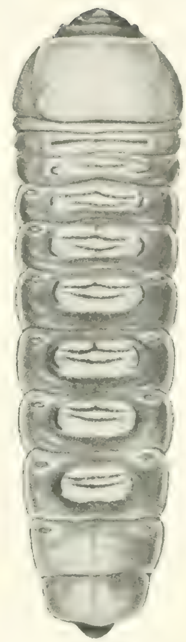
♀ The antennae hardly reach to middle of elytra, and are more slender than in male. Hind breast with no tawny pubescence. Last ventral segment with rounded hind margin. (*Descr. after Gahan.*) Length, ♂ ♀ 29–53 mm. Plate xvii, fig. 2.

Larva.—A large, yellowish-white, elongate, much-corrugated, thick grub, with stout black mandibles, and a large hard prothoracic shield dorsally. Fig. 1 in plate.

Pupa.—Yellowish-white, stout, with the general appearance of the beetle, the parts such as the antennae, wings, legs, etc., being free and pressed against the sides and breast.

Life History.

The beetles appear on the wing during the monsoon, July and August, pair, and the eggs are laid at this period. The egg is placed in an interstice in the bark, and on hatching out the small grub bores down to the bast and sapwood and feeds in this. Whilst young the sapwood is only slightly grooved (pl. xvii, fig. 3, A), but as the grub increases in size and its mandibles become stronger it works down deep into the sapwood, filling the whole of the gallery and depression thus made between the outer shell of the bark and the inner layer of the sapwood with wood particles and excreta (fig. 3, B). A large irregular area is thus eaten out which may be as much as 5 in. across and 4 in. high, the edges being irregular and stretching at times a fifth or a fourth round the tree. When full-fed the grub tunnels down into the wood to pupate, usually from a point at one of the lower edges of the depression



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Lophosternus hügelii, Redtenb.—1, larva; 2, beetle; 3, portion of the base of an oak stem (with part of the bark removed) showing the shallow gallery, *A*, made in the sapwood by the young larva; also the deeper excavation, *B*, made as the larva reaches full growth, and the entrance-hole, *C*, to the tunnel eaten down into the wood for pupation. Kumaun, North-West Himalaya.

(fig. 3, C). This tunnel is carried deep down into the wood, curving upwards at its orifice in the outer sapwood. When the grub has got far enough down into the hard wood it eats out a pupating-chamber parallel to the long axis of the tree and of larger diameter than the tunnel leading to it. Both tunnel and pupating-chamber are free of all wood particles and excreta, and to get rid of these latter a hole is cut through the bark, and they are pushed out through this. It is the presence of these holes and the heaps of wood-dust and excreta to be seen at the foot of the tree which renders it easy to recognize the presence of the insect in the tree, although externally no trace of the depression in the bast and sapwood is visible.

The larva eats out the pupating-chamber in May and changes to a pupa in June. The total period passed in the larval stage is unknown. The life-cycle is, however, unlikely to be of more than a year's duration.

Damage Committed in the Forest.

The grub's method of feeding destroys portions of the bast layer, whilst its mode of pupation results in large tunnels and chambers being driven into the heart-wood of the tree. The insect must infest a tree in considerable numbers to kill it, and probably only does so when the oak is sickly owing to serious infestations of the bark beetle *Dryocoetes hewetti* (p. 545), or by the parasitic *Loranthus vestitus*. The damage done to the timber of the tree is, however, more serious. The large circular holes and borings in oak timber, the work of this beetle's grubs, are well known in the Western Himalaya, and often render the wood unfit for other than firewood purposes.

This beetle is the common pest of oak timber known to the Breweries, and reported from Naini Tal and Mussoorie on several occasions. The beetle is to be found commonly on the wing in the early part of the monsoon in Mussoorie, Naini Tal, etc.

The cutting out and conversion of sickly trees which are found to be badly attacked by the bark bettle or by the parasitic *Loranthus* should prove a sufficient remedy against the increase and spread of this pest.*

PARAPHRUS.

Only one species of this grub is at present known from the Indian Region.

Paraphrus granulosus, Thoms.

REFERENCE.—Thoms (*Cyrtognathus*), *Essai Class. Ceramb.* p. 329 (1861); Gahan, *F.B.I.* Cerambycidae no. 13, p. 14 (1906).

Habitat.—Bashahr State, North-West Himalaya. Also reported from Mungphu (Sikkim); Burma, Thayetmyo, Moulmein, North Chin Hills (Watson); Thaungyin Valley (Bingham); Kakhien Hills (B. L. Stanton); Siam.

Tree Attacked.—Oak (*Quercus ilex*). Kotgahr, Bashahr.

* *Vide* my paper, "The *Loranthus* parasite on *Quercus dilatata* and *Q. incana*."—*Jour. As. Soc. Bengal*, v, 189 (1909).

Beetle.—Brick-red in colour, head and antennae sometimes dark brown, the latter twelve-jointed. Prothorax almost flat above, with three spines on each side, the posterior ones the shortest; finely and very closely punctate over its whole area. Elytra somewhat rugulose, closely and very finely punctulate. Last ventral segment of body with an arcuate emargination at the apex. Third joint of tarsus with its cleft extending three-fourths of the way to the base, and its lobes obtusely rounded at the end. Length, ♂ ♀ 33 mm. to 65 mm.; breadth, 11 mm. to 25 mm.

Description.

Life History.

Towards the end of July 1909 Mr. A. J. Gibson, in charge of the forests of the Bashahr State beyond Simla, procured specimens of a longicorn which has been identified as either this species or a new species of the genus. Mr. Gibson states that the grubs of this longicorn tunnel into the wood of the *Quercus ilex* and are responsible for the holes and tunnels found in the timber of this tree. This seems to be the first record of the insect responsible for this work.

PRIONUS.

Both the known Indian species have been taken in the forests. The antennae are twelve-jointed.

Prionus corpulentus, Bates.

REFERENCES.—Bates, *P.Z.S.* 1878, p. 720, ♀; id. *Scientific Results Second Yarkand Mission*, Coleopt. p. 21, pl. i, fig. 18 ♀ (1890). Gahan, *F.B.I.* Ceramb. i, no. 14, p. 15 (1906).

Habitat.—Kalatope Forest, Chamba, N.W. Himalaya. Gahan gives Murree, Kashmir.

Tree Attacked.—? Kharshu Oak (*Quercus semicarpifolia*). Chamba Oak Forests.

Beetle. — This beetle is readily distinguished from the *Lophosternus*, which it resembles in shape, by the heavy-jointed antennae, each joint being produced laterally into a long process.

Description.

♂ Pitchy brown in colour; the antennae are a little longer than body, 12-jointed, each joint from third to eleventh produced laterally into a long process, third joint twice as long as first and about half as long again as fourth, fourth to eleventh sub-equal in length, twelfth longer than eleventh. Prothorax much broader than long, bispinose at each side, dull with two small

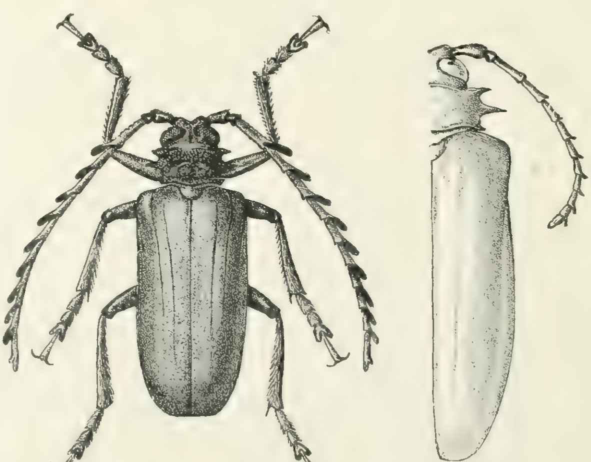


FIG. 189.—*Prionus corpulentus*, Bates. × 6/5. North-West Himalaya. (*F.B.I.*)

slightly raised glossy spaces near the middle. Elytra more than twice as long as broad, dull; finely rugulose and very minutely punctulate. Thorax beneath rather thickly covered with long tawny hairs, abdomen with very short sparsely scattered hairs. Last ventral segment sinuate at apex.

♀ Antennae much shorter (see fig. 189). Abdomen glabrous, the last ventral segment with rounded hind margin. Length, 36–46 mm.; breadth, 11–17 mm.

Life History. I am of opinion that this insect infests the Kharshu oak in the Western Himalaya. I have taken the beetle *on* oak trees of this species towards the end of June, and longicorn grubs of large size, and resembling the grubs of this group of the Cerambycidae, infest this tree.

Prionus elliotti, Gahan.

Reference.—Gahan, *F.B.I.* Ceramb. vol. i, no. 15, p. 16 (1906).

Habitat.—Fort Sandeman, Baluchistan. Gahan in *Fauna* gives Baluchistan (near Quetta) (C. Elliott); Fort Sandeman (Capt. James).

Tree Attacked.—Poplar ?

Beetle.—Resembles the last in having the heavily jointed antennae with the long side prolongations to joints. Only the male insect appears to be known. Black above; antennae, legs,

Description. and body beneath pitchy brown; tarsi reddish brown. Head impressed with a median groove less distinct behind. Antennae scarcely extend beyond middle of elytra, joints third to eleventh each with a long process projecting obliquely; third about one-third longer than first, and twice as long as fourth, its process half as long as joint itself; fourth to eleventh sub-equal in length, the ramus of each much longer than stem; twelfth nearly twice length of eleventh. Prothorax with two spines on each side—one short at anterior angle, the other long and slightly recurved just before the middle. Elytra less than twice as long as broad. Breast thickly covered with long greyish hairs; the abdomen with some shorter sparsely scattered hairs; third joint of hind tarsus cleft in middle. Length, 33 mm.; breadth, 13 mm.

Life History. This insect was apparently first taken near Quetta by Mr. C. Elliott, late Conservator of Forests (then Deputy Conservator of Forests in Baluchistan). Gahan's original description of the species was made from this specimen. The only other record of this insect I know is that of Captain James, Officiating Political Officer, Zhob, who sent me a specimen of the male beetle from Fort Sandeman in January 1909. The tree it infests is unknown, but is not improbably a species of poplar.

Acanthophorus.

The single species as yet reported from India is one of the largest tree-infesting longicorns known.

Acanthophorus serraticornis, Oliv.

References.—Oliv. (*Prionus*), *Ent.* iv, no. 66, p. 14, pl. 9, fig. 33 (1795); Serville (*Acanthophorus*), *Ann. Soc. Ent. Fr.* i, p. 153 (1832); Gahan, *F.B.I.* Ceramb. i, no. 20, p. 23 (1906); Stebbing, *Injur. Ins. Ind. For.* p. 80 (1889).

Habitat.—Sál Forests of Chota Nagpur and Ganjam. Gahan in *Fauna* gives Madras, Mysore, Trivandrum.

Tree Attacked.—Sál (*Shorea robusta*, Gaertn.). Singbhum (*mihi*) and Ganjam (S. Cox).

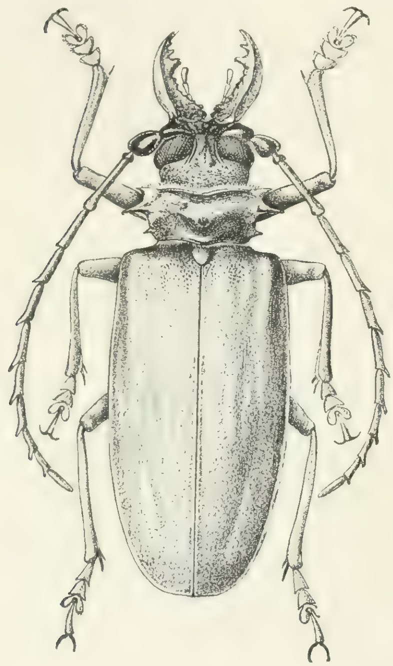


FIG. 190.
Acanthophorus serraticornis, Oliv. ♂.
Singbhum and Ganjam. (*F.B.I.*)

Description.

Beetle.—♂ Reddish tawny in colour, with the head, basal half of the antennae, and prothorax black or brownish black. Head punctate or granulate behind; eyes large, the space between them rather less than one-third of whole head; mandibles variable in size and form. In large specimens they are longer than the head, divergent from the base to the middle, and thence gradually incurved to the tip, each armed with two or three strong teeth on the inner side between the middle and the tip; in small males they are similar in size and form to those of the females. Antennae twelve-jointed, with the joints from the fifth to the eleventh produced each into a strong dentiform process at the apex. Prothorax unevenly convex, glossy in the middle, more or less pubescent near the sides; front and hind margins fringed with tawny hairs. Elytra for most part coriaceous and dull, but sparsely punctured and glossy near the base; each with a very closely punctured basal spot. Breast pubescent.

♀ Mandibles not so long, straight from the base to about the middle, incurved at the end, armed with several teeth along the inner edge. Antennae shorter; last ventral segment longer and rounded at the apex. Length, 53 mm. to 92 mm.; breadth, 17 mm. to 28 mm. (*Descr. after Gahan.*)

Life History.

I first took this beetle in the sál forests in Chota Nagpur (Singbhum), in August 1896. In 1897 I discovered that the insect lived in the tree, the larvae tunnelling into the bast and sapwood. The beetle appeared on the wing early in June, and the egg-laying period for this locality may be taken to be between July and August, and perhaps later. The grubs feed in the tree throughout the remainder of the year from July onwards. The period passed in this stage of their existence has not yet been recorded. In the year 1907 Mr. S. Cox forwarded to Dehra specimens of the beetles from Ganjam. They were taken on the wing at night in June, and were sent in connection with a serious attack of longicorn and buprestid borers in the mango plantations at Chicacole (*vide* pp. 218, 297, 369). There was no evidence, however, to show that the *Acanthophorus* had issued from the mango-trees, and the fact of its infesting this tree has not been substantiated.

Aegosoma.

With Gahan's revision of the Cerambycinae only one species of the genus has now been reported as a pest, and that doubtful.

Aegosoma costipenne, White.

References.—White (*Megopsis*), *Cat. Coleop. B.M. Longic.* i, p. 28, pl. 2, fig. 2 (1853); *Aegosoma lacertosum*, Pasc. *A.M.N.H.* (3), xix, p. 413 (1867); *I.M.N.* ii, p. 12; Gahan, *F.B.I.* Ceramb. i, no. 45, p. 49 (1906).

Habitat.—Kulsi, Assam. Gahan gives Assam; Sikkim; Manipur (Doherty).

Tree Attacked.—Teak (*Tectona grandis*). Kulsi Teak Plantation, Assam.

Beetle.—♂ Ferruginous red and opaque, the elytral costae nitid and of a brighter red colour. Upper surface bare of pubescence. Antennae a little longer than body, the third and a few of following joints tipped with black at apex, third rather more than twice as long as first. Prothorax with a sharp angular process at the base on each side; unarmed at the anterior angles. Elytra each with four costae, the outer one reaching the apex, whilst a second nearly does so, the remaining two being short; apex subtruncate near suture, armed with a short spine at the suture.

Description.

♀ Antennae reaching to posterior third of elytra. Prothorax with a reddish callosity occupying space between the prosternal suture and the lateral edge. Ovipositor short and compressed. (*Descr. after Gahan.*) Length, 25 mm. to 30 mm.; breadth, 7 mm. to 9 mm.

Fig. 191.
Aegosoma costipenne, White.
Assam.

Life History.

In 1890 the Forest Officer, Kamrup, Assam, reported that the young teak trees in the Kulsi Teak Plantation were suffering from insect attacks. Specimens previously sent to the Indian Museum had shown that the insects were species of *Stromatium* (see p. 292). The Forest Officer was asked to send further specimens of beetles. In reply three distinct species of longicorns were sent, one of which proved to be this species. The record does not state whether the beetles were actually taken from the trees (*I.M.N.* ii, p. 12). This is at present the only authority for stating that this beetle infests teak.

Sub-Family 2.—LEPTURINI.

Head elongate and gradually or abruptly narrowed behind eyes; antennae fairly close to base of mandibles; latter frequently provided with a ligamentous fringe and molar tooth at base; front coxae conical and prominent.

Only two genera are at present known to contain species of forest importance.

Apatophysis.

Apatophysis sp. prox. modica, Gahan.

Reference.—Gahan states that this species appears to be near to but quite distinct from *modica*, Gahan.

Habitat.—Fort Sandeman, Zhob, Baluchistan.

Tree Attacked.—*Vitis vinifera.*

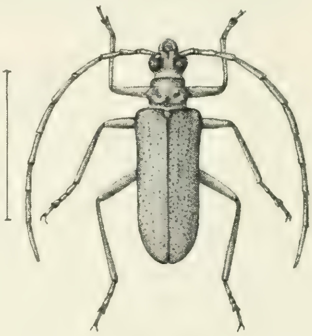


Fig. 192.
Apatophysis sp. prox. *modica*, Gahan. Fort Sandeman.

Beetle.—Small, rather slender, yellowish brown, head and prothorax darker; antennae covered with a greyish pubescence except basal joint, which is shining-brown. Head finely rugose, eyes large; first joint of antennae long, swollen anteriorly, second joint very short, rest subequal, shortening apically. Prothorax convex and rough on disk, sides produced medianly into a blunt point, the outer posterior angles produced into sharp points. Elytra smooth, glabrous, constricting behind, apices separately rounded; finely punctate, apical portions covered with a short, fine, golden pubescence. Under-surface slightly darker, pubescent. Length, 11 mm. to 13 mm.

Description.

This beetle was sent to me in December 1908 by Captain E. H. S. James, Assistant Political Agent, Zhob, from Fort Sandeman, where he reported it as having been found on the vines in the gardens of the station.

Teledapus.

It is possible that there may be more than one species of this genus infesting the conifers of the North-West Himalaya.

Teledapus dorcadioides, Pascoe.

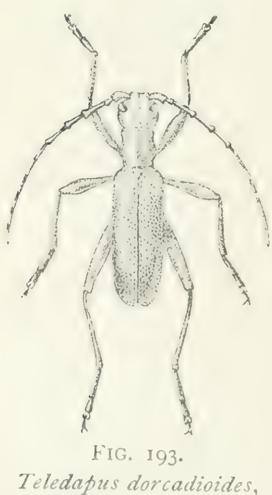


Fig. 193.
Teledapus dorcadioides, Pascoe. ♂. × 4/3.
Western Himalaya. (*F.B.I.*)

References.—Pascoe, *A.M.N.H.* (4), viii, p. 269, pl. 13, fig. 1 (1871); Gahan, *F.B.I.* Ceramb. no. 72, p. 77 (1906).

Habitat.—Western Himalaya—Mussoorie, Jaunsar.

Trees Attacked.—Deodar (*Cedrus deodara*); Spruce (*Picea morinda*).

Beetle.—Apterous in both sexes. Elongate. Varies from reddish brown to dark brown in colour. Head large, strongly exserted; finely and very densely punctate, with a faint short grey pubescence; vertex impressed with a median line extending along base of clypeus. Prothorax almost as wide at apex as at base, a little protuberant medianly, broadly constricted between the middle and apex, a shallow sinuate groove near base and a median line along the disk; surface finely and very densely punctulate. Scutellum covered with a dense greyish tawny pubescence. Elytra densely and strongly punctured all over. Body beneath and legs somewhat more pubescent than on the upper side. Femora gradually and slightly thicker from the base

Description.

Nothorrhina muricata, Daln., in *Pinus longifolia*.—1, 1*a*, 1*b*, larva, pupa, and beetle : 1*c*, larval galleries in the outer sapwood ; 1*d*, pupal chambers in the sapwood. Kumaun, North-West Himalaya.

to a little past the middle of their length ; the hind pair in the male reach to the apex of the elytra. In the male the first joint of the hind tarsus is longer than the remaining joints united ; in the female the first joint is equal in length to the two others together. Length, 14 mm. to 20 mm. ; breadth, 3 mm. to 4½ mm. (*Descr. after Gahan.*)

Life History. Little is at present known on the subject of this most curious cerambycid. According to Gahan it is the only species of the genus *Teledapus* known. To my knowledge it is the only wingless longicorn that has yet been reported in connection with damage in the Indian forests. Specimens of the beetle were taken on two occasions on 19 April 1902, by Babu B. Sen Gupta, then a student at the Forest School at Dehra. The first specimen was taken in a standing dead but not dry deodar-tree at Mundali in Jaunsar, and another in a standing dead spruce, both in the sapwood. The grubs evidently feed in the bast and outer sapwood, and the beetles probably emerge from the tree some time in May or early June to pair and oviposit in fresh trees. This is as far as the life history has been taken at present.

NOTHORRHINA.

The genus contains a notable pest of the *Pinus longifolia.* This is the first report of the occurrence of the genus in India.

Nothorrhina muricata, Daln.

REFERENCE.—Daln. Schönh. *Syn. Ins.* i, 3, App. p. 193 (1817).

Habitat.—*Pinus longifolia* tracts in North-West Himalaya.

Tree Attacked.—Chir Pine (*Pinus longifolia*). Jaunsar, Tehri Garhwal, Kumaun, Almora, Chamba.

Beetle.—Narrow, elongate. Black or rufous-brown, moderately shining ; antennae brown ; under-surface brown to orange-brown, shining. Head finely rugose-punctate between the roundish black eyes placed on each side ; antennae short, slender, first joint swollen, second short, third longer than second, shorter than first, rest longer except last two, which are short. Prothorax flat, wider than broad, the posterior outer angles rounded, coarsely rugose on sides, the rugosities and imbrications strongest anteriorly, the disk convex medianly, smooth, shining, and finely punctate. Elytra broader than prothorax at base, sides parallel, apices separately rounded ; striate-punctate, the longitudinal striae rather indistinct, the punctures irregular and fine and interrupted by short irregular transverse striae and reticulations. Under-surface finely punctate. Legs slender, light yellowish brown. Length, 13 mm. to 18 mm. Plate xviii, fig. 1*b*, shows this beetle.

Description.

Larva.—A thick whitish elongate grub with a pale brown prothorax which is broader than the other segments ; the latter are tuberculate. Head small, yellow, mandibles black. Length 18 mm. to 25 mm. (fig. 1.

Pupa.—Elongate, white, slender, narrow, tapering posteriorly. Antennae, legs, and wings are pressed against the chest. Length, 15 mm. to 21 mm. Fig. 1*a* shows the ventral surface of the pupa.

Life History.

The beetle appears on the wing in the forest some time in June, probably first issuing about the middle of the month. The female oviposits in June and July, the eggs being laid in crevices of the thick bark of the tree. The grubs on hatching out bore down to the bast layer, and feed at first entirely in this, eating out a winding gallery. With the growth of the grub this gallery increases in depth and width and grooves the sapwood as well as removing all the inner bast layer of the bark. These galleries differ to some extent in appearance, being taken either straight up parallel to the long axis of the tree, or winding about indefinitely with a good deal of horizontal direction (fig. 1*c* in plate). The larval galleries are always packed with a mass of wood excreta and dust ejected by the grubs, which fills them, and owing to their darker brown colour renders them conspicuous objects in the inner bast and on the outer sapwood. The winter is passed in the half-grown larval stage, the grub remaining at the end of its tunnel in a semi-comatose condition, and not feeding during the colder and frosty months of this season. With the advent of spring the larva wakes up, recommences feeding, and carries the larval gallery in the bast and sapwood for some distance further. When full-fed it bores down into the sapwood, eating out a tunnel about three-quarters of an inch to one inch in length. This tunnel is carried down either at right angles or at an acute angle to the surface of the sapwood, and ends in a chamber of two or three times the diameter of the tunnel, which is eaten out parallel to the long axis of the tree; this chamber is the pupal chamber, and the larva changes to a pupa in it (*vide* fig. 1*d*). The head of the pupal chamber is always blocked with a mass of wood fibres, and the larva may close the entrance to it with a similar mass before pupating. The grub changes to a pupa towards the end of April, and about six weeks are spent in the pupal and immature beetle stages. When mature the beetle crawls out of the pupal chamber and up the tunnel made by the larva in the sapwood, this tunnel as well as the pupal chamber being always quite free of wood-dust and larval excreta, and bores its way through the bark, and so escapes from the tree. After pairing the female lays the eggs of the next generation in the bark of fresh trees. The insect passes through only one life-cycle or generation in the year.

Damage Committed in the Forest.

It will be seen from a study of the life histories of the buprestids *Capnodis* and *Anthaxia* (pp. 202, 212), and of this longicorn, all of whom infest the chir pine, that there is a very considerable similarity in the method of attack of these beetles. The egg is laid in crevices of the bark of the tree, and the grub on hatching out feeds in the bast and sapwood. If the insects are plentiful in a tree they will in time destroy all the bast layer and the tree will die. And this is the danger to which the chir pine is subject from these insects. The beetles attack the tree from the sapling stage upwards, and are at times to be found in considerable numbers. Only green, sickly, or dying

trees or newly felled ones are infested. Dead trees are not attacked. This longicorn beetle appears to be commoner in the trees than either of the buprestids.

Protective and Remedial Measures.

The remedies and methods of protection against this pest which can be instituted will be found detailed under *Cryptorhynchus brandisi* (p. 433). The best time to put them into force would be the winter months, when all these insects are in the larval stage in the bast layer of the tree. A simple plan to ascertain the abundance of the insects in the forest is to fell a few trees, or, better still, ring them and leave them as trap trees. A monthly examination of these trees will show how plentiful the insects are on the area. If the trees are found to be heavily attacked by the buprestid, longicorn, or weevil larvae, it will mean that the insects are numerous in that area, and steps will have to be taken to get rid of them.

Leptura.

A number of Indian species of these small longicorns are known, but only one as of forest importance.

Leptura rubriola, Bates.

References.—Bates, *P.Z.S.* 1878, p. 720 ♀; id. *Scientific Results Second Yarkand Mission*, Coleopt. p. 22, pl. 1, figs 21 and 22 ♂ ♀ (1890); Gahan, *F.B.I.* Ceramb. vol. i, no. 75, p. 81 (1906).

Habitat.—Kainthli, Chamba, North-West Himalaya. Gahan gives Kashmir, Murree, near Gulberg, 5,000–9,000 ft. (Dr. Atchison), and Lidder, 11,000 ft.

Tree Attacked.—Spruce (*Picea morinda*). Chamba State.

Description.

Beetle.—♂ Black, with the elytra from the base to a little beyond the middle yellowish red (at times the elytra are completely black). Head dull, finely and closely punctured. Antennae nearly as long as body, third joint scarcely longer than fourth and a little shorter than fifth; eleventh about one-third longer than tenth. Prothorax a little longer than broad, slightly constricted, and transversely channelled just behind the front margin, widest at base, narrowed in front, dull and closely punctured. Elytra strongly and closely punctured and dull save at apex; apices broadly truncate and slightly sinuate, feebly dentate at each of the angles. Hind tarsi very long, the first joint nearly twice as long as the next two united; third joint cleft to the middle; claw-joint long.

Fig. 194.
Leptura rubriola, Bates. ♂ · ♀. Western Himalaya. (*F.B.I.*

♀ Prothorax, except along front and hind borders, and the whole of the elytra, red. Antennae not extended beyond the middle of the elytra, with fourth joint distinctly shorter than third. Length, 11 mm. to 15 mm.; breadth, 3½ mm. to 5 mm.

I took a specimen of this beetle on a large girdled dying spruce-tree at Kainthli in Chamba on 22 June 1909. The insect, a female, was deep down in a crevice of the bark and was egg-laying.

Sub-Family 3.—CERAMBYCINI.

Head variable in form, but seldom distinctly narrowed behind eyes; mandibles never provided with a ligamentous fringe or molar tooth at base. So far as at present known this is by far the most important sub-family of the three to the forester.

Eighteen genera comprising twenty-five species are known to be injurious to forest trees in the country. Some of these are pests of first-class importance, such as *Hoplocerambyx spinicornis* of the sál in the Central Provinces and Assam, *Æolesthes holosericea* of the United Provinces sál areas, *Trinophyllum cribratum* of the deodar, and *Æolesthes sarta* of the soft-wooded but valuable poplars and willows of Baluchistan.

Tetropium.

This would appear to be a genus of some importance in the North-West Himalaya.

Tetropium oreinum, Gahan.

Reference.—Gahan, *F.B.I.* Ceramb. i, no. 88, p. 95 (1906).

Habitat.—Bashahr State. Gahan gives West Kashmir (Lt.-Col. Steatham); North-West Himalaya (E. P. Stebbing).

Tree Attacked.—Deodar (*Cedrus deodara*). Ralli Forest, Bashahr State; Jaunsar—Konain, Pajidhar.

Fig. 195. *Tetropium oreinum*, Gahan. × 3/2. N.W. Himalaya. (*F.B.I.*)

Description.

Beetle.—Black or brownish black, the upper side for the most part dull, the under-side and legs somewhat glossy. Head sparsely clothed with tawny setae; densely rugulose-punctate, marked along the vertex and front with a median groove. Prothorax sparsely setose; widest a little before the middle, narrowed more towards the base than in front, marked with a transverse groove a little in front of the basal margin, the latter not raised; surface finely and very densely granulated, except on two or three small areas in front which are punctate and slightly nitid, and on a small smooth median callosity near the base; disk with a slight depression along the middle. Elytra densely punctate and somewhat glossy near the base, the rest of their surface covered with a very short dark pubescence, more or less opaque. Body beneath very sparsely clothed with tawny pubescence. Femora fusiform, laterally compressed. Length, 9 mm. to 14 mm.; breadth, 2½ mm. to 3½ mm.

Life History.

A specimen of a mature beetle was taken by myself from the sapwood of green felled deodar-trees in the Ralli Forest of the Kailas Range in the Bashahr State on 24 June 1901. The following year I took the same insect in green deodar at Pajidhar in Tehri Garhwal. The beetle appears on the wing from the middle of June into July. It lays its eggs in crevices of the bark of newly felled green deodar-trees or in standing sickly ones. The young larvae, on hatching out, feed at first in the fresh sappy bast layer, afterwards grooving the sapwood. The gallery is long, rather broad, shallow, and is carried in a wavy manner in the long axis of the

tree. When full-fed the larva eats out a longish narrow pupal chamber in the sapwood and pupates here. This pupating-chamber is usually from half an inch to an inch down in the sapwood, and is parallel to the long axis of the tree. The beetle on maturing crawls up the entrance-tunnel to the pupating-chamber, eats a hole through the bark above, and escapes from the tree.

That the beetles lay in absolutely green trees is evidenced by the fact that I took tiny larvae at the most two weeks old from a tree which had been felled less than a month previously. The inner surface of the bark of this tree contained numerous small flat shallow chambers made by the newly hatched grubs. Some were so tiny that they could not have been more than a day or two out of the egg. Scarcely one was yet old enough or had sufficiently strong mandibles to be able to feed in the sapwood. At the same time a number of the beetles were taken ovipositing in crevices in the bark of the tree. They flew about quickly in the sunshine, and do not appear to be affected by the light as is the case with some of the larger longicorns. The length of time spent in the larval stage has yet to be ascertained. It is, I think, improbable that there are two generations in the year, though it is possible that the beetles issue irregularly throughout the summer and early autumn.

On 7 November I took numerous partly grown longicorn larvae, having the appearance of *Tetropium* ones, from the upper portion of the main stem of a large green deodar felled on 1 October at Konain in Jaunsar, and at the time being converted into sawn material. It would seem probable that these larvae had issued from eggs which were laid on the tree after it was felled some five odd weeks before. The tree was a perfectly healthy large old one.

Parasitic Insect.

An examination of several deodar logs near Konain showed that the beetle had infested them in large numbers. It evidently attacked the trees in conjunction with *Scolytus major* (see p. 568), a bark beetle which was also exceedingly plentiful. The longicorn had gradually increased in considerable numbers, and apparently with it one of its insect parasites, probably an ichneumon. I was unfortunately unable to find any of the flies, as they had all left the trees; but the greater proportion of the longicorn pupal chambers in the sapwood contained a small, white, elongate, narrow pupal case with vertical sides, which was evidently the pupating-chamber of a parasitic hymenopterous insect. In every instance examined these cases had a small hole at one end, with a corresponding hole in the bark above it, through which the parasite on maturing had escaped from the tree. It appeared therefore that the numbers of the longicorn had been decimated this year by the parasite, its grub having lived parasitically on or in the longicorn larva till it had reached full size, when the latter had died from exhaustion, and the parasitic grub then pupated.

Tetropium sp.

REFERENCE.—Mr. Gahan identifies this as a species of *Tetropium* near to the European *fuscum*, Fabr., but requires further specimens to make certain of the identification.

Habitat.—Deota, Tehri Garhwal, and Simla, North-West Himalaya.

Tree Attacked.—Spruce (*Picea morinda*). Deota, Simla.

FIG. 196.
Tetropium sp.
North-West Himalaya.

Description.

Beetle.—♂ A stoutish beetle. Head and prothorax black, covered with a yellow pubescence when living; head and thorax punctate. Antennae about same length as insect, brown in colour, basal joint large. Legs long, dark brown, with broadly ovate flat femora. Elytra brown with a purplish tinge, and a yellowish pubescence on basal portions; each with two well-marked raised lines running down it. Under-surface black, the abdominal segments thickly set, especially laterally, with short yellow pubescence. Length, 16 mm.

♀ Slightly longer and narrower than ♂. Thorax narrower and shorter, head smaller; elytra narrower across base and leave the pygidium exposed. Antennae shorter than body, about half length, the basal joints less swollen than in ♂. Femora of posterior legs not so enlarged and flattened. Under-surface black, more or less shining on head and thorax; abdominal segments shining, with only a slight pubescence laterally. Length, 19 mm.

Life History.

The beetle appears on the wing about the middle of June, pairs, and lays eggs in spruce-trees. From the appearance of the trees in which beetles and grubs have been taken it would seem probable that this beetle will lay in trees almost if not quite dead, and that the grubs can feed upon bast which has lost the greater amount of its sap. In this respect this insect would appear to differ in its habits from the deodar *Tetropium*, whose larvae require perfectly fresh bast to feed upon. The larvae feed in the bast and sapwood, eating out long winding galleries five to seven inches in length, which have a general direction parallel to the long axis of the tree. These galleries are packed with wood-dust and excreta. When full-fed the grubs tunnel down into the sapwood and eat out a small elongate chamber parallel to the long axis of the tree and pupate in this. In the cases where the tree infested is an old one with a thick bark on the lower parts of its trunk the larvae eat out their pupating-chambers in the thick bark instead of going down into the sapwood. The larvae spend from about the end of June to February or the first part of March in this stage, and then pupate, about five or six weeks being spent as a pupa, and the balance in the resting stage as a beetle. I cut out a beetle in this resting stage from its pupal chamber in a large standing dead spruce-tree in the Simla Catchment Area on 11 April 1908. The pupal chamber is from half an inch to one inch down in the sapwood. The entrance to it is blocked up with wood fibres. The beetle bores straight through the bark to escape from the tree when mature, and I have noticed that the escape holes are generally situated in a crevice, so that on issuing the beetle is sheltered from the gaze of birds, insect foes, etc., by the overhanging bark flakes.

I have not yet ascertained whether this beetle exists in the forests in any serious numbers.

I have found parasitized dead grubs of this insect in their tunnels or pupating-chambers in the wood, but I have never taken a specimen of the parasite, which is possibly an ichneumon fly.

CRIOCEPHALUS.

Criocephalus tibetanus ? Sharp.

REFERENCES.—Sharp, *Trans. Ent. Soc.*; Stebbing and James, A further note on the Chilgoza Bark-boring Beetles of Zhob, *Ind. For. Records*, i, p. 251.

Habitat.—North Zhob Chilgoza Forests. Gahan states that the type is from Tibet.

Tree Attacked.—Chilgoza (*Pinus gerardiana*). North Zhob.

Description.

Beetle.—Head and prothorax dull black. Elytra dark aeneous brown, slightly lighter apically, dull; antennae black, apical joints brownish. Front of head with a transverse furrow above clypeus, rugose and set with fine transverse striae on vertex. Prothorax widest medianly, sides rounded, the disk with three rounded depressions, the two largest placed on either side medianly, the third just above base on median line; the surface covered with fine irregularly transverse striae. Elytra wider than thorax at base, slightly broader at level of hind legs and thence constricting to apex, latter truncate and slightly spined in outer angle; striate-punctate, the striae not prominent, strongest in basal half; the punctures irregularly scattered, strongest in basal half. Under-surface black, moderately shining, covered with a fine short yellow pubescence. Length, 24 mm. to 28 mm.

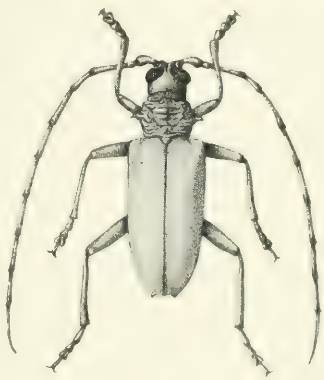


FIG. 197.
Criocephalus tibetanus ? Sharp.
North Zhob.

Larva.—A small white corrugated but slightly tapering grub about an inch to $1\frac{1}{4}$ in. in length when full-grown.

Life History.

When investigating the chilgoza bark-beetle attacks in the North Zhob forests in 1905 it was noted that many of the infested trees contained numerous longicorn larvae feeding in the bast layer and sapwood. The grubs eat out elongate winding galleries which groove both bast and sapwood, the eggs being evidently laid by the beetle on the thin outer bark of the tree. When full-fed the grubs bore down into the heart-wood and eat out in it an elongate pupating-chamber parallel to the long axis of the tree. The grubs seem to become full-fed about the end of June or first weeks in July, the beetle appearing on the wing during August and ovipositing. The life-cycle takes a year from egg to beetle, the grubs hatching from the August eggs hibernating as such in their tunnels in the tree.

Not having taken the perfect insect during my visits in June and again in November 1905, I made no allusion to this insect in my monograph entitled *Note on the Chilgoza Bark-boring Beetles of Zhob.** In a letter received

* *Forest Bulletin*, no. 3, 1905.

during the same year from Captain Barron, I.M.S., from the Shinghar Forest in North Zhob (where I had been carrying out my investigations in June), he made allusion to the work of this beetle as evidenced by the numerous holes to be seen in dead logs, etc.

To Captain E. H. S. James, Officiating Political Agent, Zhob, belongs the credit of having been the first to draw public attention to the presence of this insect in a *Note on the further ravages of the Borer Beetle of Shinghar for* 1907, addressed to the Revenue Secretary, Baluchistan Government. In this report Captain James wrote :—

> Mr. Stebbing, in his book,* mentions three varieties of Boring Beetle at Shinghar, viz., *Polygraphus trenchi*, *Phloeosinus*, and *Pityogenes coniferae*. This season, I believe, a fourth species, not mentioned by Mr. Stebbing, has been discovered. The beetle is much longer and thicker than the other species, being about half to three-quarters of an inch in length without its antennae, and of a dark brown colour. I secured two specimens of both beetle and larva, which have been sent to the Forest Extra Assistant Conservator. He has been asked to give any information about them that he can, and then send them to the Quetta Museum. This species is far more destructive than the borer. It appears to attack dry trees as well as green ones, and in the latter the larvae were invariably found among those of the *Polygraphus trenchi*. In dry trees they leave a clean-cut hole extending far into the wood which looks as if a rook-rifle bullet had been fired into it. . . . In some parts of the forest there are large numbers of old holes made by this species, but not many living specimens were found. They were discovered, however, in both Old and New Shinghar.

This is a valuable note on the life history of this beetle. These longicorn beetles, when in numbers, can of course kill off trees with as great a facility as the bark-boring Scolytidae, as is evidenced by the attacks of *Æolesthes sarta* in the trees at Quetta (p. 307). Sometimes, however, they come into trees which have already been infested by the bark-borer beetles, and this was the case in Zhob during the great bark-beetle attack of 1900–05. Of course, when present, they greatly assist the bark beetles to kill off the tree. I am of opinion that the beetles of this species do not lay their eggs on the bark of dead trees. The young larvae require a sappy bast during the first portion of their lives. The holes seen in dead timber are the old entrance-tunnels leading down to the pupating-chambers from which the beetles have long since issued. When beetles are found in the pupating-chambers in the wood of newly dead trees it is probable that the eggs were laid in the tree the previous year whilst it was still alive or newly felled or blown down.

The subject of remedial measures against this insect will be found discussed under the chilgoza bark-borers (p. 517).

Hypoëschrus.

Hypoëschrus indicus, Gahan.

Reference.—Gahan, *F.B.I.* Ceramb. i, no. 97, p. 104 (1906).

Habitat.—United Provinces. Gahan gives Karachi; Calcutta, Belgaum.

Tree Attacked.—Sál (*Shorea robusta*). United Provinces.

* *Forest Bulletin* no. 3, 1905.

Beetle.—Light brown. Head impressed with a median line. Head and prothorax very finely granulate and dull. Antennae longer than body in male, not so in ♀; third joint longest. Elytra somewhat glossy, very closely punctured; each with seven raised lines, the third and fifth most prominent and connected with one another, and the seventh by means of oblique cross lines posteriorly; the first runs close to posterior edge, the sixth and seventh obsolete in front, and the sixth obsolete posteriorly. Length, 12 mm. to 20 mm.; breadth, 3 mm. to 4½ mm.

Description.

FIG. 198.
Hypoëschrus indicus, Gahan. ♂. × ⅜. (*F.B.I.*

This beetle has been taken in pupating-chambers in the sapwood of the sál in the United Provinces and Oudh. The grubs live in the bast layer, but the life history has not been worked out.

XYSTROCERA.

An important species with a wide distribution is known to infest pyinkadu.

Xystrocera globosa, Oliv.

REFERENCES.—Oliv. (Cerambyx) *Entom.* iv, no. 67, p. 27, pl. 12, fig. 81 (1795); Coquerel, *Ann. Soc. Ent. Fr.* 1848, p. 180, pl. 7, iv, fig. 2, *a*, *b* (larva); Gahan, *F.B.I.* Ceramb. vol. i, no. 99, p. 106 (1906).

Habitat.—Salween River, Tenasserim; Assam. Gahan gives India: Mussoorie, Darjeeling, Assam, Madras, Mysore, Bombay; Ceylon, Burma. Siam, Malay Peninsula, Java, Celebes, Philippines, Egypt, Mauritius; Hawaian Islands.

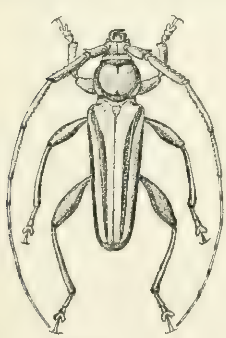


FIG. 199.
Xystrocera globosa, Oliv. ♂.
Assam; Burma. (*F.B.I.*)

Trees Attacked.—Semul (*Bombax malabaricum*): Assam; Pyinkadu (*Xylia dolabriformis*): Salween River, Tenasserim.

Beetle.—Reddish brown; prothorax with the front and hind borders, a narrow median longitudinal band (sometimes obsolete) and a broad lateral band, which in the ♂ runs obliquely from the side of the thorax in front towards the medio-basal lobe behind, metallic blue or green; elytra testaceous yellow, the outer and apical borders and, on each, a median longitudinal band, which anteriorly is directed obliquely towards the shoulder, also metallic blue or green. Head densely punctate. First joint of antennae asperate, with spiniform anterior process at the apex; third to fifth strongly asperate, each in ♂ with apex thickened and dentate beneath; third joint thicker and about a quarter shorter than fourth. Prothorax densely and finely granulated on the disk in ♂, less densely so in ♀; prosternum of the male with a transversely striated glossy band of metallic colour close to the front margin, the rest dull red in colour. Elytra densely and rather strongly punctured; each with three slightly raised longitudinal lines—two dorsal and one lateral. Length, 15 mm. to 32 mm.

Description.

Larva.—The larva is bright yellowish white with a small brown head and black mandibles.

Pupa.—White, and of ordinary longicorn shape.

Life History.

This insect was taken in all stages of larva, pupa, and beetle in a large pyinkadu-tree in a clearing close to the Salween River. The tree had been felled about a month previously, and was still green. Specimens of the insect were taken between the 8th and 11th March 1905. The grubs feed in the bast and sapwood, principally in the latter, as the bark of the tree is very thin. The grubs were mostly full-grown at this period, but the majority of the beetles were still immature. A few perfectly developed insects were, however, taken from the pupal chambers.

The grubs feed at first in the bast and sapwood, eating out winding galleries which become broader as they proceed. These galleries are tightly packed with excreta and wood particles. Each gallery is distinct, but when the grubs are as numerous as in this case the galleries are liable to interlace at times. When more than half-grown the larva bores down into the wood (at A, fig. 200), the tunnel down into the wood being straight at first and then gradually curving until it again becomes parallel to the long axis of the tree. A broad irregular gallery is then eaten out in the wood (as shown in fig. B), which is closely packed with excreta and wood-dust. When full-grown and ready to pupate the grub curves the gallery once more, eating out a narrow chamber parallel to the long axis of the tree, but deeper in the wood (C). This chamber is at times situated below the portion B of the gallery. In this chamber, which is quite free from wood particles and excreta, the larva changes to the pupa stage.

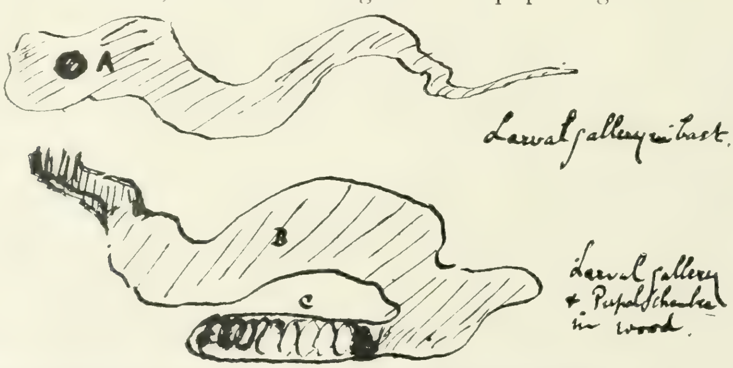


FIG. 200.—Larval gallery and pupating-chamber of *Xystrocera globosa*, Oliv., in pyinkadu. Salween River, Tenasserim. (E. P. S.)

As I have said, the insect was taken in all the stages of larva, pupa, and beetle, though no beetles had yet left the tree so far as I was able to observe. It is probable that the beetles appear on the wing in April, and it is perhaps possible that the insect passes through two generations in the year.

Although in the tree in which it was found the insect was extremely numerous, I was unable to find any predaceous or parasitic insects infesting it.

The larvae, when numerous, completely destroy the bast layer of the tree, and the insect must therefore be classed as a pest of some importance so far as the pyinkadu is concerned.

I have also taken this beetle on the wing in Mussoorie, but in spite of its wide distribution, as shown by Gahan, nothing appears to be known about its habits in the Himalaya. It undoubtedly lives on a variety of different trees.

In Assam this longicorn lays its eggs in the semul (*Bombax malabaricum*). A log of this wood was sent to Mr. A. J. Gibson, Imperial Forest Economist, in 1908, and from it he bred out specimens of the beetle. The larvae lived in this wood in a similar manner to those infesting the pyinkadu. Beetles issued from the semul in Dehra Dun in the middle of August. It is probable that they issue at an earlier date from this tree in Assam, and not improbable that the insect passes through two generations in the year in that province.

I saw the attacks of this species in *Albizzia lebbek* trees in Egypt during a tour I made in a part of the country in 1907. It was reported in this connection by Mr. Willcocks, who stated that it committed very serious damage.

Stromatium.

The genus is by no means such an important one as was supposed. Gahan, in his *Fauna* volume, reduces the known Indian species to two in number.

Stromatium barbatum, Fabr.

References.—Fabr. (*Callidium*), *Syst. Ent.* p. 189 (1775); Oliv. *Entom.* iv, no. 70, p. 10, pl. 4, fig. 41 (1795); *Callidium fenesum*, Boisd. *Voy. d'Astrolabe*, ii, p. 481 (1835); *Ind. Mus. Notes*, vol. i, p. 59; ii, p. 11; Stebbing, *Depart. Notes*, vol. i, p. 182 (1902); Gahan, *F.B.I.* Ceramb. vol. i, no. 108, p. 114 (1906).

Habitat.—Assam; North-West India; Central Provinces; Ravi Valley, Chamba State. Gahan, in *Fauna*, gives India; Ceylon; Burma; Andamans; Mauritius; Bourbon; Madagascar.

Trees Attacked.—Teak?: Assam; *Acacia catechu*: Dehra Dun; Sissu: United Provinces Terai; *Dendrocalamus strictus*: Raipur, Central Provinces; Mango: Pusa? (Lefroy).

Description.

Beetle.—Varies in colour from brownish black to reddish brown, faintly covered with a tawny pubescence. Head densely and rather coarsely punctured above and at the sides; as densely, but less strongly, punctured in front. Antennae much longer than body in ♂, not so in ♀. Prothorax very densely covered with strong, coarse punctures; the disk, with five slightly raised tubercles, less distinct in the ♂, placed two anteriorly, one behind the middle, and two near the base; the sides broadly and obtusely protuberant except near the base in the ♀; straighter, with a tomentose depression, in ♂. Elytra coarsely and very densely punctured; each with two fairly distinct dorsal and one or two short lateral costae, the latter sometimes obsolete; a short sutural tooth at apex. Length, 12 mm. to 29 mm.; breadth, 4 mm. to 7½ mm. (*Descr. after Gahan.*)

Fig. 201. *Stromatium barbatum*, Fabr. ♂. N.W. India, Assam, Central Provinces. (*F.B.I.*)

Larva.—A white, thick grub, with a wide, dark brown head, black mandibles, and a pale brown shining prothorax, larger in breadth than the rest of the segments. The body segments are flattish. Length, 25 mm. to 30 mm.

Life History.

This beetle has a wide range in the country, and it is probable that the date of its appearance on the wing varies slightly in different parts. The insect has been reported as infesting a variety of trees, but so far as I have been able to ascertain it is typically an example of that group of longicorns which confine their attention to dead wood, and breed in this latter. Of this group we at present know very few examples in India.

In *Indian Museum Notes*, Cotes remarks in the first number of that periodical issued (1889) that damage was noticed as being done to deal-wood boxes lying in the godowns of the museum by the larvae of this beetle. That such damage is common to the specimens in wood museums is well known. Both Messrs. Gamble and Oliver, Directors of the Imperial Forest School at Dehra Dun, as also Messrs. Smythies and Gleadow, reported from time to time damage to the museum wood specimens from beetles which, when identified, proved to be this pest. In addition to *Acacia catechu* I have taken it in sissu wood, and commonly in packing-case wood, etc., in Dehra. The insect is also well known in the Museum of the Reporter on Economic Products in Calcutta.

The insect was sent to me by the late Mr. A. M. Long, I.F.S., from the Raipur Division in 1901, where it was taken in dry bamboos. I have since taken it numerously from bamboos, and it is one of the insects responsible for the holes with a squarish section to be seen commonly in bamboos in thatched roofing and elsewhere.

H. M. Lefroy, in *Indian Insect Life* (p. 378), mentions it as infesting mango wood.

The only record I can find of its being supposed to have been taken infesting green trees is the reported beetle attack in the Kulsi teak plantations in Assam, mentioned in *Indian Museum Notes*, vol. ii, pp. 11, 12. An examination of the note given there will show that the insect responsible for the severe destruction in the plantations between 1873 and 1878 or 1879 was identified as *Stromatium asperulum* (*S. longicorne*, see below). In February 1890 the attack had again made itself evident, and larvae were forwarded to the Indian Museum. As the result of a request for mature insects, no less than three distinct species of longicorns were sent to the museum, viz., *Stromatium barbatum*, *Neocerambyx* (*Æolesthes*) *holosericea*, and *Aegosoma lacertosum* (*costipenne*), *S. asperulum* not being represented. The fact that these beetles were actually taken from the affected trees is not stated in the note, nor have I been able to obtain an authoritative statement on this head. From the life histories of two of these species as at present known to us, it would appear doubtful, therefore, whether we can accept the statement that *Stromatium barbatum* lives in green trees.

The life history as known at present is a simple one. The beetle appears on the wing as early as the latter part of April or May in some parts, in June and throughout July and on into August in Dehra Dun, and

requires dry and hard wood in which to lay its eggs. It does not oviposit in rotten timber. The grubs live in the wood, eating out winding tunnels, which are blocked with wood-dust and excreta. When full-fed, they eat out a short length of tunnel, which curves to a certain extent, and pupate here. The work of these larvae, as also of the mature beetles, as they gnaw through hard wood with their mandibles, can be often heard in the wood specimens in museums in India. The beetle, on maturing, bores its way out of the wood.

I think there is only one generation of the insect in the year, but am not certain on this point.

To protect wood specimens they should be soaked in a dilute solution of arsenic. In Dehra I have found that this does not afford a permanent protection either against this insect or the bostrychid borers, and specimens have to be resoaked when the wood is seen to be again attacked.

Stromatium longicorne, Newman.

(*The Kulsi Teak Borer.*)

REFERENCES.—Newman (*Arhopalus*), *Entomol.* i, p. 246 (1840); *Stromatium asperulum*, White, *Cat. Col. Brit. Mus. Longic.* p. 300 (1855); ?*Stromatium laticolle*, Pascoe, *Trans. Ent. Soc. Lond.* (3) iii, p. 532 (1869); A. G. Mien, *Ind. Forester*, vol. iv, p. 347 (1879); Cotes, *Ind. Mus. Notes*, vol. ii, p. 11; Gahan, *F.B.I.* Ceramb. vol. i, no. 109, p. 115 (1906).

Habitat.—Kulsi Teak Plantations (Gauhati, Assam). Gahan gives Assam (Doherty); Upper Burma; Tenijo (Fea); Hong Kong; South China; Siam; Malay Peninsula; Philippines; Borneo; Celebes; Ceram, Amboina; Batichan.

Tree Attacked.—Teak (*Tectona grandis*). Kulsi, Assam.

Description.

Beetle.—Varies from testaceous to dark brown in colour, rather densely covered with greyish-tawny pubescence. Antennae nearly twice as long as the body in the ♂, a little longer than body in ♀; first joint closely punctulate, caniculate anteriorly near the base in the ♂. Prothorax strongly and densely punctate, the punctures more or less hidden by the pubescence, dilated and somewhat rounded at the sides in the male, its width across the middle equal to that of the elytra, and marked with a large, densely tomentose depression on each side; more sharply rounded at the sides in the female; the disk with four very feeble obtuse tubercles, and a submedian callosity. Elytra rounded at the apex, armed each with a sutural spine; the surface rather densely punctured, the punctures more or less covered over by pubescence, marked also with numerous large, conspicuous punctures, with raised front edges, each with a tawny seta. Length, 17 mm. to 25 mm.; breadth, 4½ mm. to 7½ mm. (*Descr. after Gahan.*)

FIG. 202. *Stromatium longicorne*, Newman. ♀.

FIG. 203. *Stromatium longicorne.* ♂. Assam.

Mr. Gahan adds: "This is a widely distributed species, and the variation in size is pretty considerable. In some males the

prothorax is relatively not so wide as in larger males; it is possible that *S. laticolle*, Pasc., founded upon a large male from Batichan Island, is only a form in which the prothorax has reached its maximum of development."

Larva.—A whitish-yellow, thick-set, tuberculate grub, with a dark brown head, black mandibles, light brown shining prothorax broader than first abdominal segment; abdominal segments taper slightly posteriorly, all save the last two, with an elliptical-shaped area of minute tubercles on the dorsal surface. Length, 37 mm.

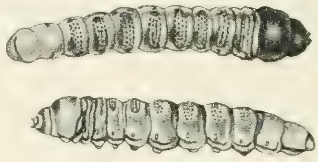


FIG. 204.
Larva of *Stromatium longicorne*.

Life History.

There can, I think, be little doubt that this is the true Kulsi Borer of teak, the insect of which Mr. A. G. Mien, I.F.S., studied the life history in 1877, and of which he wrote an account in the *Indian Forester* in 1879. Mr. Mien found that larvae were present in infested stems throughout the year, and so was of opinion that the insect passed through two generations in the year. The grubs were first observed to be injuring the trees in 1873, but the mature insect was not discovered until 1877. At the end of March in that year Mr. Mien collected some sections of stems containing larvae and kept them under observation, obtaining beetles from them on 21 June. The pupating and resting stage is thus probably about two months. The following is an extract from Mr. Mien's interesting note* on this subject:—

"Simultaneously with the establishment of the experimental teak plantations at Kulsi, Assam, there appeared an insect which may yet cause considerable damage amongst the young teak, although up to the present time its attacks have not been very serious, only a small percentage of the trees having suffered, many of which recovered partially or entirely.

"The first symptom to be observed is the swelling just above the ground, or sometimes a couple of feet up, of the stem, which is occasionally of a considerable size. On close examination, small punctures in the bark may be noticed, just beneath the swelling, from which the excrements of the larvae exude.

"After a hot day the young trees have a fading appearance, though not invariably, and the leaves shrivel up. Frequently this symptom is, however, not present, and the young tree remains apparently vigorous until the larvae have bored their way so far into the stem that the tree is snapped off by the wind. The globular swelling is evidently the result of the efforts of Nature to repair the damage, and is sometimes successful, insomuch that the tree continues to live and thrive, though with diminished vigour. On cutting over the stem, and slitting it carefully open so as to bisect it longitudinally, the larva may be discovered a little above the

* Note on the occurrence of the Teak Borer Beetle in Assam: *Ind. For.* iv, p. 347.

swelling, in the cavity formed by its having eaten away the pith ot the tree completely for several inches in an upward direction.

"It appears usually in one- and two-year-old trees, but has also been found in trees of five to six years' growth."

The small punctures in the bark referred to by Mr. A. G. Mien would be the holes made by the grubs to admit air into the gallery, which, as he states, is blocked with wood-fibre and excreta, part of which is got rid of at the aeration outlet. Some of these fibre particles are used to make a rough kind of semi-cocoon, when the grub pupates, in a manner similar to that shown for *Coelosterna scabrata* (pl. xxv).

Some of the beetles bred out by Mr. Mien were evidently sent to the Indian Museum in Calcutta, since a specimen in the collections is marked "Kulsi Teak-borer." In 1890 the attack again broke out, and larvae were again sent to the Indian Museum.

It was the consignment of beetles subsequently sent, consisting of species of *Æolesthes* and *Aegosoma*, with *Stromatium barbatum*, not apparently specifically stated to have been taken from the trees, which gave rise to the confusion over the true Kulsi Teak-borer. That this insect was indisputably identified and determined as the author of the damage by Mr. A. G. Mien eleven years before seems hardly open to doubt.

Treatment.

According to Mr. Mien, the treatment instituted at the Kulsi plantations to get rid of the pest was to coppice all young and badly attacked poles, and encourage the growth of the strongest shoot from the stool by removing the rest when they appeared. Older and more vigorous trees, which did not appear otherwise sickly or fading, were left alone, and often recovered from the effects of the borer's attacks, though traces of the globular swelling invariably remained.

PLOCÆDERUS.

The genus was for long thought to contain the worst sál longicorn pest. Investigation has shown that this is not so. The known Indian species of importance, *obesus*, has, however, a wide range in the forest.

Plocæderus obesus, Gahan.

REFERENCES.—Gahan, *Ann. Mag. Nat. Hist.* (6) v, p. 51 and (6) vi, p. 259 (1890); [illegible] Cotes (nec White), *Ind. Mus. Notes*, i, no. 2, pl. v, fig. 4; *Monochamus* sp., Thompson, *Rep. Ins. Injur. Woods and Forests*, Allahabad (1878); Stebbing, *Depart. Notes*, i, 368 (1902); Gahan [illegible] Ceramb. no. 117, p. 121 (1906).

Habitat.—Throughout India, with the exception of the Bombay Presidency, from which at present there is no record of its presence

Trees Attacked.—Sál (*Shorea robusta*): Dehra Dun; *Odina wodier* (Jhingham): Dehra Dun; *Bombax heptaphyllum*: United Provinces Terai; *Butea frondosa* (Dhàk): United Provinces Terai; *Bombax malabaricum* (Semul): United Provinces; *Spondias mangifera*: Tista Valley, Eastern Himalaya

(900 ft.)—Thapal, Saharanpur District; Mango (*Mangifera indica*): Chicacole, Ganjam, Madras.

Description.

Beetle.—The beetle is chestnut-brown in colour above, clothed with a short dense tawny-grey pubescence, and lighter-coloured below, the legs and antennae being of the same colour as the upper surface; the head, upper and lower edges of thorax, and outer and inner edges of elytra, black. The head slopes forward at an angle, the eyes are kidney-shaped, the antennae taking off from the inner angle of the eye; the first joint of the antennae is large and swollen, the remainder long and swollen at the nodes, where they are black; they are longer than the total length of the insect in ♂, of the same length or slightly shorter in ♀. The thorax has a transverse ridge at upper and lower edges, and the vertex is covered with small raised irregular transverse ridges; the outer edges are produced into a spine medianly. The elytra have a distinct shoulder to the upper outer angle, the tips being truncate and spined. In the ♀ the last segment of the body projects beyond the elytra. The legs have four-jointed tarsi, the third joint is deeply cleft in a heart-shaped manner, the fourth joint being inserted in the cleft near the upper end of the third. Length, 27 mm. to 45 mm.; breadth 9 mm. to 15 mm.

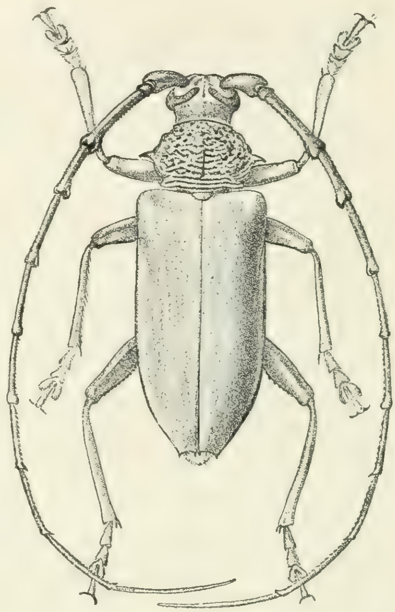


FIG. 205.—*Plocæderus obesus*, Gahan. ♂. × $\frac{6}{5}$. India. (*F.B.I.*)

Larva.—The larva when quite small is elongate, never curved, white in colour, with soft yellowish head and mandibles and twelve segments of nearly equal size. As it increases in size the head becomes yellowish brown, the mandibles large, powerful, and black, and the body-segments roundish, wrinkled, and thick, the hind ones tapering slightly, the prothoracic one being the largest and hardest. Length, 2½ in. to 3 in.

Pupa.—The pupa is yellowish white and has the shape of the mature beetle; the elytra, however, are soft, white, and curled down on the breast; the antennae are held pressed over the back, and the legs are pressed against the sides. The eyes are large, prominent, and black, the tips of the mandibles also black, and the jointed palpi prominent. Length, 1½ in.

Cocoon.—The pupa lies free in a curious calcareous whitish cocoon, which to some extent resembles a pigeon's egg. These cocoons are to be found lying at the ends of the larval tunnels in the wood of infested trees (fig. 206).

Life History.

Observations made in the Siwalik forests in the United Provinces, with others carried out in Sikkim, practically complete the life history of this insect for the more northern parts of India, in the Terai, and foot-hills of the Himalaya.

The beetles appear on the wing in March, and soon after pair and lay eggs in the bark of either sickly or freshly felled trees. From these eggs small grubs hatch out in April and feed for a time in the bast layer, making winding galleries in the bark and sapwood. As the larvae increase in size and their mandibles become stouter, they bore down deeper into the sapwood, and spend the time until nearly full-grown eating out

deep, winding galleries, which remove all the bast below the outer bark and groove deeply into the sapwood. When nearly full-grown, they tunnel down into the heart-wood and eat out a pupal chamber in this, which is more or less at right angles to the long axis of the tree. About August-September the larva is full-fed, and changes into the pupal state within the curious calcareous cocoon peculiar to this insect. Fig. 206, from a photograph taken by M. E. Stebbing, shows these cocoons *in situ* in the tree. Pupation takes place at various depths in the tree. If some of the cocoons are broken open at the end of November the fully developed beetles will be found inside them, mature, but not ready for flight, as their outer covering is still soft. The pupal state is evidently a short one, but the beetle on maturing rests within the cocoon between December and March, whilst its outer parts are slowly hardening. If the insect is examined in December, it will be seen that the elytra are still quite soft, and that the legs and antennae are by no means ready to perform their respective functions properly. The beetle can walk about only in a weak, halting manner. It is probable that this habit of the beetle of maturing and resting for some months is the cause of the statement so often made that the insect appears on the wing in November and March in the Siwaliks. It is improbable that the insect would appear when the sharp winter of the North-West has set in, although it can be easily obtained at this season. The writer has had numbers brought to him during the winter months. Fuel-choppers continually come across them, and it is probable that the beetles obtained by them have given rise to the statement. From the above it will be evident that this insect takes a year to pass through all the various stages of its life history from egg to mature beetle.

The late Mr. R. Thompson, Conservator of Forests, was probably the first to draw attention to the damage committed in the forest by this pest in his *Report on Insects injurious to Woods and Forests*, published by the North-West Province and Oudh Government in 1878.

On p. 37 Mr. Thompson wrote: "They" (the cocoons) "were discovered beneath the bark, embedded between it and the wood, in a felled tree of the *Butea frondosa*, or dhak. The larvae had apparently only lived on the sapwood, and underwent the second metamorphosis on the site of their original operations. Another remarkable fact was that these beetles are in the perfect state as early as March. . . .

"I have since obtained numerous specimens of these beetles and their cocoons embedded to a depth of eight inches in logs of *Odina wodier* and *Bombax heptaphyllum*. They are the commonest and earliest variety of Monochami out, the perfect insects having been obtained as early in the season as November."

We also bred out this beetle at Dehra Dun from the mango logs sent from Chicacole, Ganjam, in December 1908, as seriously infested by the *Batocera titana* borer (see p. 367). The *Plocaederus* beetles issued in the breeding-cage at Dehra on 17 March and 7 April 1909.

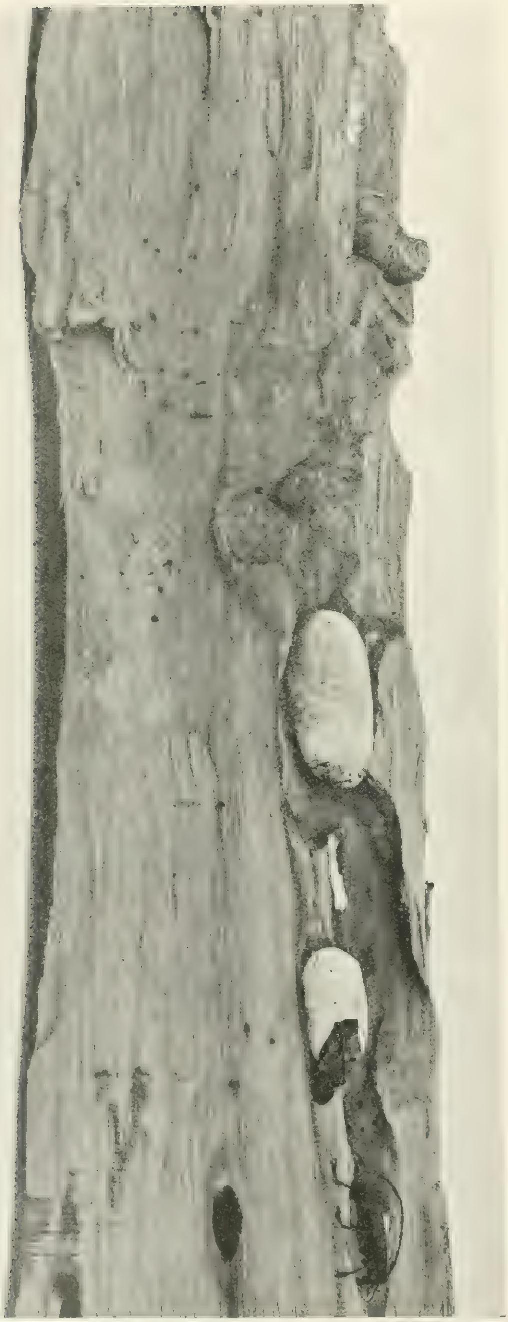


FIG. 206.—Larval galleries and pupal chambers, with cocoons and beetles *in situ*, of *Plocœderus obesus*, Gahan, in the interior of a stem of *Butea frondosa*. Siwaliks.

Damage Committed in the Forest.

The damage done by this insect is both to the bast layer and to the timber of the tree it attacks. Trees cut down in cold-weather fellings will have eggs laid in their bark in March and April, and unless the wood is removed before the ensuing rains the larvae hatching from the eggs will riddle it, and render it useless for any save firewood purposes; the weight of fuel obtained from such trees is very considerably lessened owing to the large winding borings of the larvae and the enlarged pupal cavity they eat out. The damage thus caused to the timber is probably usually of more importance than the damage done to the standing trees in the forest, though it must be remembered that the insect will oviposit in sickly standing trees and thus injure them, and even cause their death when the insect is in any numbers. In some localities green standing trees have been found severely attacked and killed by this beetle. As the insect is to be found in other parts of the country, it necessarily follows that it feeds upon a variety of trees. At present it has been actually reported as taken from sál

(I think it only infests this tree exceptionally), jhingham, dhàk, *Bombax heptaphyllum*, semul, *Spondias mangifera* (taken by myself in the Tista Valley forests in 1896–97), and mango.

Protection and Remedies.

Observations would tend to show that this insect is both hardy and has great powers of self-reproduction. It is therefore one which may cause considerable trouble in the future. Several of the trees it infests are for a variety of purposes of importance to the forester, and therefore, whenever possible, practical protective measures should be enforced against it. The most important are:

(i) Removal of dying and sickly trees from the forest.

(ii) Bark all fellings, whether poles in thinnings or mature timber, as soon as made.

(iii) If it is not possible to bark the felled material, whether poles or logs or unbarked fuelwood, it should be removed from the neighbourhood of the forests by the end of April.

Predaceous Insect.

Colydiid, sp.—The grub of this beetle is predaceous upon the larva, pupa, and immature beetle of *Plocœderus obesus*.

FIG. 207.—*Colydiid* grub at × on stem of *Butea frondosa* badl infested by *Plocæderus obesus*. The grub was taken from a cocoon of this beetle. Siwaliks, N. India.

Grub.—The larva is an elongate yellow grub, consisting of a square black head with large stout mandibles. The thoracic segments are squarish, each having a stout dorsal hard chitinous brown shining plate, and a pair of long-jointed legs. The body segments are flat, yellow, darker medianly, the eleventh ending in a stout sucker leg. The twelfth ends in a pair of stout black callipers.

Beetle.—I have not yet taken the beetle.

Life History.—The grub of this insect was taken in December inside a broken calcareous cocoon in which it was curled up, apparently hibernating or pupating. The cocoon was situated in a pupal chamber in the heart of a *Butea frondosa* tree which had recently died and was very badly infested by the longicorn, a large number of cocoons containing living beetles *in situ* being taken from pupal chambers in the heart-wood of the tree. In or alongside the broken cocoon containing this grub were the remains of the immature beetle it had consumed, the harder chitinous parts, such as head and jaws and legs and antennae, having been rejected. The grub was fat and swollen, in a comatose state, and was probably about to pupate. It is shown in fig. 207 on the piece of wood in which it was found, from a photograph taken on the spot by M. E. Stebbing.

Neocerambyx.

One species of this genus has been reported from Taunggyi in the Southern Shan States as infesting oak.

Neocerambyx sp.

Reference.—Provisionally identified by Gahan as probably two species of possibly *Neocerambyx* at present unknown to him.

Habitat.—Taunggyi, Southern Shan States.

Tree Attacked.—Oak (*Quercus griffithii*). Taunggyi (H. W. Watson).

Beetle.—Elongate. Head and thorax black, covered with a fine silky golden pubescence; elytra chestnut brown, often very dark, covered with a very fine golden pubescence giving a silky appearance to the insect. Head longitudinally channelled between the eyes and antennae, front with a deep transverse elliptical depression medianly, vertex very finely punctate, the whole except the hind portion of vertex covered with a fine golden pubescence. First joint of antenna obconical, thickened; 2nd very short; 3rd longer than 1st and 2nd together; 4th equals 1st; 5th longer than 4th but not as long as 3rd; rest sub-equal. Prothorax widest medianly, covered with wavy irregular transverse ridges with a raised "collar" on anterior and posterior margins. Elytra much wider than head and prothorax, moderately shining, smooth, sides slightly constricted at level of posterior coxae, thence straight to apical fourth and then constricted sharply to apex, which is slightly truncate; very finely punctate beneath the pubescence. Under-surface densely set with a fine silky yellow pubescence, as also are legs and antennae. Length, 61 mm.

Description.

Life History.

These beetles were sent to me by Mr. H. W. A. Watson, as infesting oak (*Quercus griffithii*) in Taunggyi in the Southern Shan States, in company with the *Massicus unicolor* described below, p. 317. The *Massicus* appears to be the chief offender, although the life history of this *Neocerambyx* is likely to be somewhat similar to that observed by Mr. Watson for the former.

ÆOLESTHES.

The beetles of this genus are easily distinguishable by the silvery or golden reflexions on their elytra. The genus is of considerable importance in the forest.

Æolesthes holosericea, Fabr.

(The United Provinces Sál Longicorn.)

REFERENCES.—Fabr. (*Cerambyx*), *Mant. Ins.* i, p. 135 (1787); *Pachydissus velutinus*, Thoms. *Syst. Ceramb.* p. 576 (1865); *Pachydissus similis*, Gahan, *A.M.N.H.* (6) v, p. 52 (1890); *Neocerambyx holosericeus*, Cotes, *Ind. Mus. Notes*, i, no. 2, pp. 60 and 89, pl. 5, fig. 3 (1889); Thompson, *Rep. Ins. Injur. Woods and Forests*, p. 24 (1867); Gahan, *F.B.I.* Ceramb. no. 124, p. 127 (1906).

Habitat.—United Provinces and Oudh Sál Belt; Hyderabad; Central Provinces; Dehra Ismail Khan; Ganjam. Gahan gives the habitat as North-West India, Bombay, Nilgiris, Ceylon, Assam, Tenasserim, Andaman and Nicobar Islands; Siam; Malay Peninsula.

Trees Attacked.—Sál (*Shorea robusta*): United Provinces and Oudh Sál Belt; *Terminalia tomentosa*: United Provinces and Oudh; *Hardwickia binata*: Oudh and Central Provinces; *Chloroxylon swietenia*: Hyderabad; *Tamarix articulata* and *Acacia arabica*: Dehra Ismail Khan; Guava: Bengal (Lefroy); Mango (*Mangifera indica*): Chicacole, Ganjam, Madras.

N.B.—The statements in *Indian Museum Notes* * that the insect infests the teak in the Kulsi plantations, Assam, and *Shorea assamica* in Assam, require confirmation. The note in question does not state that the beetles of this species were actually taken from the trees.

Description.

Beetle.—Dark brown or reddish brown, densely covered with a greyish or golden brown pubescence which has a remarkable satiny sheen as the elytra of the beetle are presented in different positions to the light, giving them the appearance of being coated in silk. This easily distinguishes it from both *Plocaederus obesus* and *Hoplocerambyx spinicornis*, with which forest officers are liable to confuse it. The head has a straight or very feebly bisinuate furrow beneath between the cheeks, this distinguishing it from *Æ. induta*. The prothorax is rounded at sides and irregularly wrinkled above, with a smooth space on disk. Length, 20 mm. to 35 mm.; breadth, 5½ mm. to 10 mm.

FIG. 208. *Æolesthes holosericea.* Fabr. ♀. 1/1. India.

FIG. 209. *Æolesthes holosericea*, Fabr. ♂. 1/1

Larva.—White in colour, almost cylindrical, constricting slightly to extremity, corrugated; the head is brown, with black mandibles; prothorax with a brown hard plate on the dorsal surface.

Pupa.—White, of usual cerambycid shape.

* Vol. ii, pp. 11–12.

This beetle was first reported as destructive to sál by Mr. R. Thompson, in his Report on Injurious Forest Insects in 1867.

Life History.

About 1889 the Director of the Imperial Forest School at Dehra Dun forwarded specimens of the insect to the Indian Museum as injurious to sál and *Terminalia tomentosa*. Neither of these reports contains information as to the exact life history of the insect, though they mention that the larvae were excessively common in sál wood. Observations on this insect were carried out by myself between 1901 and 1909, aided by Mr. R. C. Milward in 1908. As a result the various stages in the life-cycle have been worked out for the United Provinces and Oudh, where the insect is a sál pest of the first importance. The beetles make their appearance on the wing about the latter half of June and on into July. The female, after the pairing with the male, which takes place in dark crevices of the bark or on the under-side of fallen logs or other shady situations, deposits her eggs in little crevices of the bark of green fallen or felled trees, or in standing green sickly trees. That green trees are used was proved by an inspection of some large old standing ones in the Mandal Range, west of the Patli Dun, which were reported by Mr. R. C. Milward as dying under the attacks of an insect. These trees were full of the grubs and maturing beetles, and were obviously being killed by the insect.

The grubs on hatching out feed at first in the inner layers of the thick bark, eating out shallow narrow galleries here. As soon as their mandibles become stronger they leave the bark and eat out in the sapwood large, broad, flat, irregular-shaped, longitudinal or transverse galleries. These galleries may be as much as twelve inches or more in length, three inches in breadth, and a quarter of an inch deep, grooving both bark and sapwood. When the bark is thin this gallery is almost confined to the sapwood. Whilst engaged in eating out this gallery, the grub bores at intervals two, three, or more openings or aeration holes to the outside, these openings increasing in size with that of the grub. When about half to two-thirds grown, the larva leaves the outer sapwood and bores down into the heart-wood, the tunnel going in at an angle and continuing for a varying distance in the inner sap- and outer heart-wood till the grub is full-grown. It then bores down into the older heart-wood and eats out a chamber more or less parallel to the long axis of the tree. This chamber is wider than the tunnel leading to it, is of varying width and length (as the larvae when full-grown and the perfect insects vary in size considerably), and forms the pupal chamber. A mass of triturated wood fibres forms a plug at the bottom of the chamber, whilst the upper end is covered over with a curious calcareous semi-cocoon or shell, concave on the inner surface, and having the appearance of a brazil-nut on the outer. This covering, which is hard and white, is made by the larva before changing to the pupal form. It resembles the one made by *Hoplocerambyx spinicornis* and is shown in fig. 210 (cf. also pl. iv).

The larvae usually become full-grown towards the latter part of the year, about November, and may pupate then ; or more rarely perhaps they hibernate in their tunnels, and with the first warmth of spring eat out the pupal chamber in the heartwood and change into the pupal form in it in the latter part of April. In the first and more usual case, as is evidenced by the numerous holes closed by the calcareous covering seen in felled and converted timber in the cold and hot weather months, the winter is passed through in the immature beetle stage within the pupating chamber, the insect being fully formed, but all its outer chitinous parts still soft, as we saw in the case of *Plocæderus obesus*. I have taken beetles in this stage in January and February. These form the early-issuing beetles of the species, and account for the appearance of the beetle in June. In the second case, the insect spends a portion of May and June, some six to eight weeks, in the pupal stage, and issues as a beetle some time in July. Thus some four or five months are spent by the grub actively feeding in the tree. It may then either pupate (most often) at the commencement of winter, or hibernate, and pupate in the spring. The larval period in this case extends to about

Fig. 210.—Sál house-post, showing galleries and pupal chambers of *Æolesthes holosericea*, Fabr., in the wood. Garhwal, January 1907.

nine months. The pupal stage is usually from six to eight weeks. The beetle probably lives in the mature state a couple of weeks or thereabouts. It may spend several months resting in the pupal chamber to allow the chitinous parts to harden (in the case of the autumn-pupating larvae), or it may spend a few weeks (up to a month at the most, probably) in this condition.

The life history is very similar when the insect infests *Terminalia tomentosa* in the United Provinces and Oudh forests, and probably is more or less similar in the *Hardwickia binata* in Oudh and the Central Provinces. Mr. D. O. Witt, I.F.S., reported it as infesting this latter tree in the Central Provinces, finding specimens of both beetle and grub in January 1909. Pl. xix shows a section of a log of this tree riddled by the insect.

The beetle also infests the mango; specimens of the insect were bred out at Dehra Dun in the breeding cage from a log of mango, forwarded from Chicacole, Ganjam (see p. 370), in December 1908. The beetles issued between 17 March and 7 April 1909.

Specimens of a longicorn identified as this species were forwarded to the Indian Museum, Calcutta, from the Deputy Commissioner of Dehra Ismail Khan. He procured them from *Tamarix articulata*, *Acacia arabica*, and the ? "sarin" trees in November 1892. The Deputy Commissioner stated that the trees were usually attacked in the lower part of the trunk, but that branches were also infested on occasions. Trees growing in dry places appeared to be usually attacked.

Damage Committed in the Forest.

The result of this insect's attacks in sál will be known to every Forest Officer in the United Provinces and Oudh. Evidences of the tunnelling work of the larvae and their pupating-chambers covered over with the curious white calcareous covering are plentiful in freshly cut sál logs and tors, etc., in almost every sál forest in the province, although more plentiful in some than in others. The damage this pest does to the timber therefore is obvious and needs no insistence on here. It is unfortunately certain, however, that the insect is equally a pest to the green tree, as once the latter has from any cause fallen into a sickly condition, from which it might have otherwise recovered, the beetles lay their eggs in it and the larvae proceed to remove the cambium layer. In the large old trees already mentioned as having been infested by this insect in the Mandal Range (Garhwal), the whole of the upper two-thirds of the bast layer of the tree had been removed by the grubs, the inner face of the bark and outer sapwood consisting of a mass of large irregularly winding galleries going either up or down the tree or across it. Large holes appearing here and there in the sapwood showed where the grubs had bored down into the heart-wood. Again, the heart-wood is seriously destroyed by the pupating operations of the grubs, the large elliptical pupating-chambers being at times very numerous (cf. fig. 210).

Section of stem of *Hardwickia binata*, showing the galleries in the sapwood, and the entrance-holes to the pupal chambers down in the

Protective and Remedial Measures.

One method of ascertaining the abundance of this insect in a forest is to examine the timber stacked in the temporary depots in the forest for checking and marking purposes. Whilst the wood is still in these depots it is always easy to ascertain from which forests or blocks of forest it has come. I have found that the wood in these depots in the Ganges and Garhwal Divisions showed great variableness as regards attack, that coming from certain areas having been invariably badly infested (from twenty to sixty per cent. at times), whilst lots from other blocks appeared almost free from the tell-tale holes and tunnels. These depots thus form a valuable means of allowing the Divisional Officer to ascertain in which blocks of his forests the insect is most abundant and is consequently committing the most damage, and with this important knowledge ascertained it should be possible to take steps in such areas to check or stamp out the beetle.

One of the most important means of checking the insect is to bark all timber as soon as felled, or at any rate before the middle of April in any one year. Green logs left unbarked from May onwards are certain to have eggs laid in them as soon as the first beetles of the year commence to emerge. Similarly, sickly dying trees should be felled and barked even if they are in localities where the timber cannot be disposed of, as if left they serve as so many centres of infection.

Predaceous Insect.

Ichneumon ?—Thompson in his above-quoted report stated : "In their larval state these insects are open to the attacks of both Ichneumons and Acari, both parasitical insects, the larvae of which feed upon the young grubs." In a large firewood billet of sál I took one February from a pupal chamber enclosed by the calcareous covering a thick elongate white grub constricted at each end and having the appearance of an Ichneumon grub. The shrivelled skin of the *Æolesthes* grub was close by. The Ichneumon grub had apparently fed upon it as an external parasite, gradually killing it, but not before the calcareous protecting cover had been made to the pupal chamber. The grub was evidently full-fed, but had not changed to the pupal stage. It is thus probable that the parasite only pupates in the spring, though becoming full-fed in November or December.

Æolesthes induta, Newman.

(*The Satin-wood Borer.*)

REFERENCES. Newman (*Hammaticherus*), *Entomologist*, i, p. 245 (1842) ; Armitage, *Ind. Forester*, xxvii, p. 486 (1901) ; Gahan, *F.B.I.* Ceramb. no. 126, p. 128 (1906).

Range.—Low Country Forests, Ceylon. Gahan in the *Fauna* gives Ceylon, Upper Burma, Bhamo (Fea), Siam, Sumatra, Java, Borneo, Philippine Islands.

Tree Attacked.—Satin-wood (*Chloroxylon swietenia*). Ceylon.

Description.

Beetle.—This beetle greatly resembles *holosericea*, described above, in size, form, and coloration. It can be easily distinguished from the latter by the fact that the furrow crossing the under-side of the head between the cheeks is very clearly and strongly marked, and strongly arched backwards in the middle; whereas in *holosericea* the furrow is either straight, slightly arched forwards, or feebly bisinuate and not quite so deep and well defined (Gahan). Length, 23 mm. to 28 mm.; breadth, $6\frac{1}{2}$ mm. to $11\frac{1}{2}$ mm.

The observations on the life history of this insect were made by Mr. H. P. C. Armitage, Assistant Conservator of Forests, and recorded in the *Indian Forester* in 1901. I give them here *in extenso* as they appeared:

Life History.

"**Flight.**—At end of February and March. The eggs are laid in the bark of newly felled or injured trees; so far as is yet known they do not attack healthy trees. A large number of eggs must be laid in each tree, as I have found as many as thirty larvae in one small sapling, and never less than a dozen or so in one tree. The young larvae when hatched commence boring a tunnel in between the bark and the sapwood. The tunnels are exceedingly tortuous, and completely ring the tree. The sapwood of the tree has precisely similar markings on it. The larva, when full-grown, bores a hole into the sapwood, but sometimes penetrates as far as the heart-wood (my specimens went in about September, but I have known cases of their going into the wood earlier). Here he pupates, shutting off his house from the outside world by a neat door made of some calcareous substance. I annex a sketch* showing the chamber made, which is always of much the same shape and size. Here he remains until the end of the following February or March, when he undergoes his last change and emerges as a beetle. I am so far of opinion that there is only one brood a year, but this requires further investigation. Imago emerges March; larvae from April–May to October; pupal chamber excavated, September to November.

Damage Committed in the Forest.

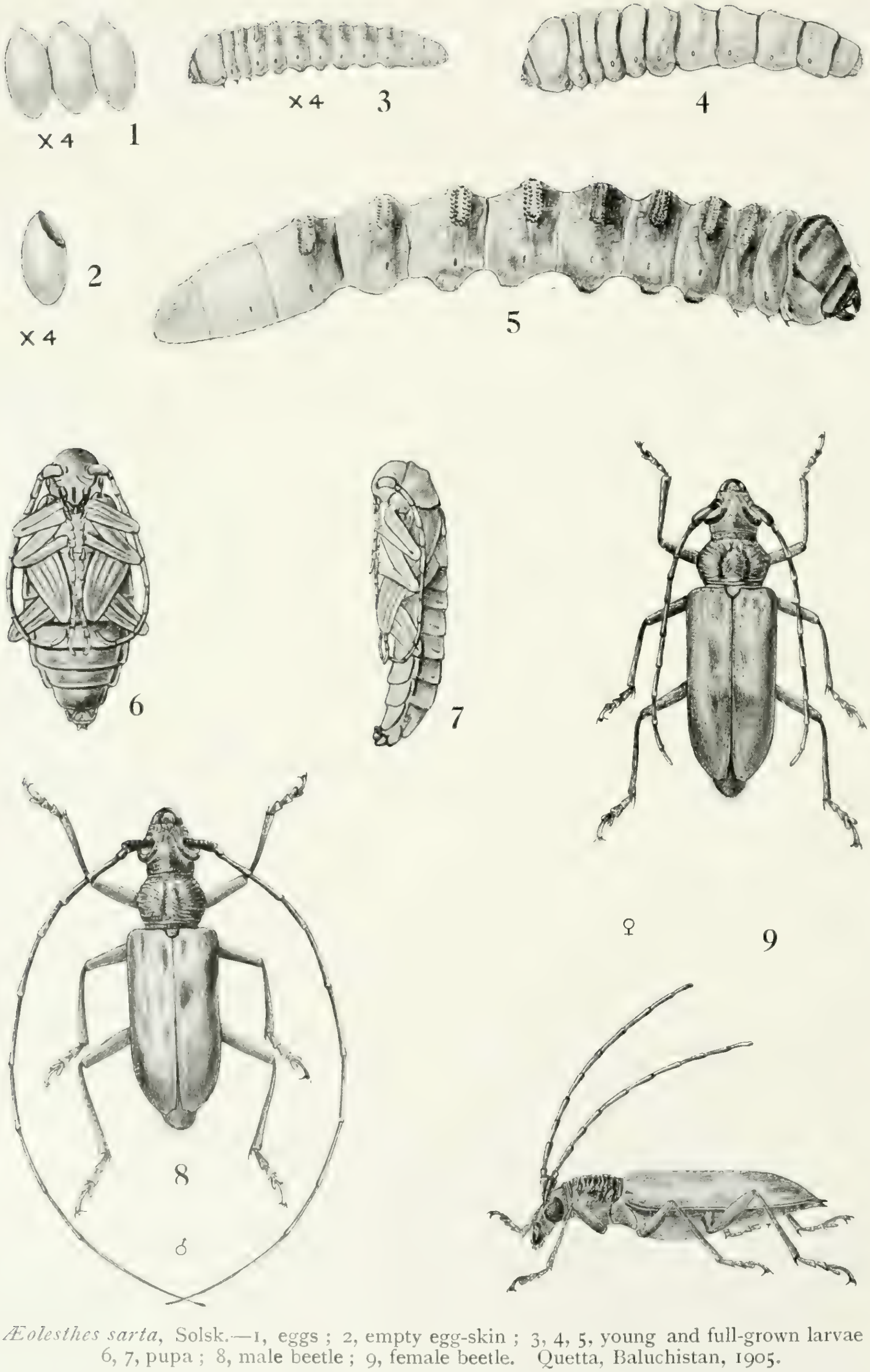
"Any one walking through our low-country forests in Ceylon, throughout which satin-wood is to be found, cannot help noticing scattered through the forest either dead branches of living trees or young dead trees of satin-wood, completely barked and studded with fairly large holes. This is the work of the *Æolesthes*. The effect of these tunnels is to cause the bark to drop off in large pieces.

"Natives frequently wound the bark of the satin to obtain the gum, which flows fairly freely, and here the beetle generally finds an opening to attack.

"*Viscum orientale*, a mistletoe, also grows on satin branches, frequently strangling and killing off the branch it is on; this is another chance for the borer, while trees growing on ridges are particularly liable to attack, as they so often have branches broken off by the wind. So far as I know, satin-wood (*Swietenia chloroxylon*) is the only tree attacked by this beetle.

* I have not been able to reproduce the sketch. Pl. iv and fig. 210 show the method of pupation of this grub.

PLATE XX.



Æolesthes sarta, Solsk.—1, eggs ; 2, empty egg-skin ; 3, 4, 5, young and full-grown larvae ; 6, 7, pupa ; 8, male beetle ; 9, female beetle. Quetta, Baluchistan, 1905.

"All satin logs felled for sale should be immediately barked, as then the beetle has no place to lay its eggs. Satin branches not marketable should be left as traps for two or three months, and then all burnt off, as twenty to thirty larvae will probably be found in each branch of any size, and hundreds could be killed off each year.

Protection and Remedies.

"Frequent thinnings and quick removal of all sickly trees."

Æolesthes sarta, Solsky.

(The Quetta Borer.)

REFERENCES.—Solsky (*Pachydissus*), *Hor. Soc. Ent. Ross.* viii, p. 150, pl. 5, fig. 4 (1871); Stebbing, *Note on the Quetta Borer* (*Æolesthes sarta*), Calcutta Supt. Govt. Printing (1905); Gahan, *F.B.I.* Ceramb. no. 128, p. 129 (1906).

Habitat.—Baluchistan: Quetta, Loralai, Fort Sandeman, &c.: Afghanistan. Gahan gives Baluchistan: Quetta (E. P. Stebbing); Turkestan, Western Tibet.

Trees Attacked.—Poplars [*Populus alba*, *P. euphratica*, *P.* sp. (*raemer*)], Willows (*Salix alba*, *S. babylonica*), Plane (*Platanus orientalis*), Elm (*Ulmus* sp.).

This insect attained a wide notoriety in Quetta and throughout Baluchistan, where, under the name of "the Borer," it did enormous damage in the years 1900–07 to the avenues of poplars, willows, and elms in Quetta itself and in other stations and gardens in the province.

Description.

Beetle.—This beetle can be distinguished from the other species of the genus by the pubescence thickly coating the elytra, which is glistening silvery or satiny grey in life, instead of a golden or coppery satiny sheen. The plate on the disk of prothorax is not well defined, and more or less rugose. The elytra are obliquely truncate at the apex, the outer angle being unarmed and the sutural one dentate or shortly spined. The antennae are more than twice length of body in ♂, less than length of body in ♀. Length, 33 mm. to 44 mm.; breadth, 9 mm. to 13 mm. Pl. xx, figs. 8, 9, shows the ♂ and ♀ beetles.

It will be often found that beetles taken on the wing or from off the bark of trees some time after they have issued from the pupating-chamber will have lost some or perhaps most of the distinguishing silvery grey pubescence from the upper surface of the elytra, which then show black with a faint violet sheen or dull olive green in living specimens.

Egg.—The egg is milky-white in colour, elliptical in shape with pointed ends, and from 3.2 mm. to 4.2 mm. in length. Pl. xx, figs. 1 and 2, shows the eggs.

Larva.—When first hatched out the larva is a small grub about a quarter of an inch in length; the head is brownish, with small black mandibles and yellow body. After a few days the body segments become a dirty black in colour. The full-grown larva is a large, thick, yellow to yellowish-white grub as much as three inches in length and five-eighths of an inch across at the upper and broadest end. The coloration is sometimes almost orange in tint. It consists of a head followed by twelve well-marked segments, the hinder ones being more deeply constricted than the four front ones. The head is small, black, the base being brown; the mandibles black and powerful. The segment following the head is very much enlarged, as are also the following two; from the latter the segments gradually taper backwards, the last being about half the width of the first and bluntly pointed;

the spiracles, situated on each side of the second and fourth to eleventh segments, are narrow, somewhat elongate, and brown in colour ; a pair of minute legs are present on the under-side of each of the thoracic segments. Figs. 3, 4, and 5 show a young grub, a grub a third grown, and a full-sized larva.

Pupa.—The grub changes into a white or whitish-yellow object bearing some resemblance to the future beetle. It is, however, broader and quite soft. The legs, wings, and antennae of the future beetle can be seen pressed against the body ; as they grow longer, the wings are seen to be curved round so as to lie on the breast of the pupa ; the legs are pressed tightly against the lower surface, and the antennae are pressed close to the sides. Gradually, as these parts reach their full development, the beetle is seen to have acquired its adult form. Size of a female pupa, 31 mm. to 43 mm. in length by 9 mm. to 15.5 mm. across body. Figs. 6 and 7 show a ventral and side view of the pupa.

Life History.

The beetle appears on the wing in Baluchistan towards the end of the first week in May, and is found in greatest abundance till the end of the month; fewer issue in June, and by the middle of the month the mature insect disappears.

The Egg Stage.—The eggs are laid in small clumps of from five to eight or ten together at wounds such as are left at spots where branches have been lopped or at other places on the bark from which the sap is oozing. The beetle evidently seeks for such spots to save herself trouble, since if they are not available she has to pierce through the bark to reach the cambium before the eggs can be laid. This is necessary, as the young larvae require the sappy bast to feed upon as soon as they leave the egg. The number of eggs laid by the beetle appears to be about fifty, this number having been taken from the bodies of females on several occasions. Scattered eggs have been found in the sappy bark, but the eggs are usually laid in clumps. The period passed in the egg stage is short, probably at most from five to ten days, as young larvae half an inch in length and as much as a week or ten days old were found in the trees at the end of the month. The period would, however, vary with the temperature—the greater the latter, the shorter the time passed as an egg.

The Life History of the Larva.—The young larva on hatching out feeds in the soft sappy bark until its mouth parts are strong enough for it to attack harder substances, when it goes deeper down until it reaches the sapwood and commences boring out a winding gallery which grooves both this and the bast. The sapwood is grooved deeper and deeper as the grub grows older. The gallery eaten out is a broad irregular winding one and is packed with triturated materials ejected by the grub after having been passed through the body; the gallery is very broad, as much as twice to two and a half times the breadth of the grub making it, and the grub can turn round in the free space at the end in which it is lying. It is evidently a voracious feeder. Several galleries in the sapwood measured were as much as 9 in. to 16 in. in length excluding curves, and 4 in. in breadth. The grub spends all the summer and autumn making this gallery. As soon as the winter sets

in it eats a tunnel down into the heart of the tree. The tunnel so made may be carried more or less horizontally, or may go in at an angle; it is 3 in. to 5 in. in length, being much broader than the diameter of the grub constructing it, and the latter can easily turn round in it (see fig. 211). The winter is spent in eating out this tunnel, and the larva thereby escapes the cold which it would feel in severe seasons if it remained just beneath the bark in its gallery in the sapwood. This accounts for the at first inexplicable fact that the great cold experienced in Quetta during the winter does not apparently in any way affect the number of beetles issuing from the trees in the spring, even after very severe winters. As spring approaches, the larva commences to carry this tunnel in the wood in the direction opposite to that in which it originally proceeded, and the portion of the tunnel now eaten out is the pupal chamber. This is some three inches in length, and may be completed by about the end of May (see fig. 211). A number of full-grown larvae at rest in this chamber and just about to pupate were taken on the last day of this month. It was noted that these larvae varied greatly in size, but this has no significance, since the beetles themselves vary very greatly in size. This difference in size may be due to a certain extent to the degree of hardness of the wood of the tree in which the grub is living. It was noted, for instance, that the galleries in elm were of smaller dimensions than those usually found in the white poplar, these latter being invariably large. The size of the tunnel in the wood itself will also of course vary with that of the larva, but from the commencement where it leaves the sapwood gallery down to the turn into the pupal chamber it is always of considerable width, so broad that the larva can turn round in it. Its length, however, may be but little more than that of the grub itself.

It will be seen from the above that the larva takes from twelve to fourteen months to reach its full growth after leaving the egg.

The Pupation of the Larva.—The larva pupates in the long axis of the tree, and the pupal chamber appears to be invariably bored out in a direction contrary to that in which the larva was lying at the time it commenced this work. This chamber is always straight or but slightly curved, and comparatively narrow when compared with the rest of the gallery in the wood above it. Having prepared the chamber, it plugs the top with a mass of gnawed wood, and lines the sides at times, if not always, with a papery lining of a brownish fibrous material. If it has not previously done so, it now backs out of the chamber into the broader tunnel above, turns round in this, and proceeds backwards down into the chamber again and builds across the top of the latter a thick white wall of some calcareous substance, lining the sides of the chamber with the same material for a short way down. This wall effectually blocks up the chamber and prevents the entrance of enemies, who would be able to attack and feed upon the helpless insect whilst in its quiescent or pupal state. The time of pupation

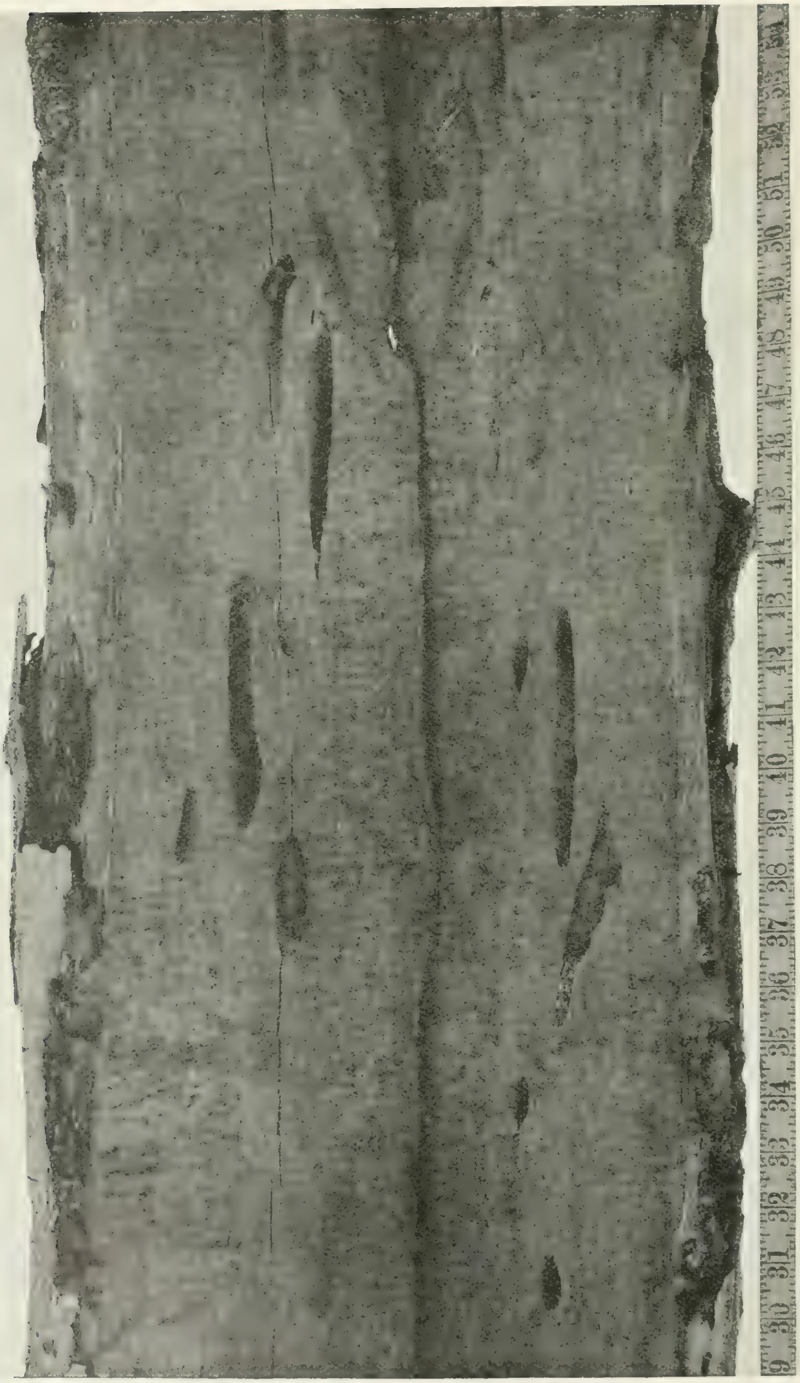


FIG. 211.—A split-up willow-stem showing pupating-chambers of *Æolesthes sarta*, Solsky, in the heart-wood. Quetta, May 1905.

of the larva will vary by a week or so, depending upon the climatic conditions; but the end of the month of May and during June may be taken as the period during which the greater bulk of the grubs in the trees change into the pupa state. Larvae hatching from eggs laid by beetles issuing as late in the year as July and August will pupate in these months of the succeeding year. Fully formed pupae have been cut out of the pupal

FIG. 212.—Section of willow-stem showing entrance-tunnels to pupating-chambers and pupating-chambers of *Aeolesthes sarta*.
Quetta, October 1905.

chamber in the trees in September and October. The fact that the fully formed beetles have been taken from the pupal chambers in February indicates that the time passed in the pupal stage is probably about four to five months.

The Adult or Beetle Stage.—The insect commences to acquire its adult form in November or December (this period will vary by a week or two), and then passes several months resting in the pupal chamber, whilst its outer parts harden and solidify. When they have done so, the beetle may, in exceptional circumstances, bore its way out of the tree by gnawing a tunnel straight to the outside through the wood. The insect does not, however, usually leave the tree in this manner. It simply breaks the calcareous partition made by the larva at the top of the pupal chamber and crawls up the broad larval tunnel in the wood and gnaws its way through the bark. In the majority of cases this would appear to be its method of leaving the white poplar trees. The beetles commence to appear from about the beginning of May, and probably in April in years of mild winters and early warm springs. Considerable numbers are still to be found in the first part of June. The adult is much scarcer in July and August, though individuals are said to continue to issue during these months. The beetles pair soon after issuing, and the eggs are probably laid by the female within a week to ten days afterwards. As has been already mentioned, the eggs are deposited by the female in the sappy bark of the tree, and to reach this, unless she can find any convenient wounds such as are made by lopping branches, abrasions to the trunk during heavy storms, etc., she bores down through the bark by means of her mandibles, forming small saucer-shaped depressions, and, pushing her ovipositor down into these, deposits a cluster of eggs. She probably repeats this operation five or six times in different spots on a tree or trees. The egg-laying as also the safe hatching out of the eggs is undoubtedly greatly facilitated by (*a*) the presence of wounds on the trees, and (*b*) a warm dry spring, since a greater number of the young larvae hatching from the fifty eggs laid will reach full development. The male beetle dies after pairing with the female, and the latter after she has deposited all her eggs in the trees. The dead bodies of the beetles are to be found lying at the foot of the trees; they are, however, probably quickly eaten up by small rodents and other insectivorous mammals and also by birds, since even towards the latter part of May (in 1905), when the beetles were issuing in thousands from the trees in Quetta, dead insects were by no means numerous. From the above notes on the life history it will be seen that the insect takes two years to pass through its life history or life cycle: a fortnight in the egg; 5½ months feeding in the bast and sapwood beneath the bark; 6½ months in the wood in the interior of the tree; 5 months as a pupa; about the same time resting as a beetle in the pupal chamber; and 2 to 3 weeks in the beetle form outside the tree engaged in pairing and egg-laying. When annoyed or frightened, the beetles, both male and female, produce a squeaking sound by rubbing the posterior inner dorsal edge of the prothorax over the anterior outer dorsal edge of the mesothorax, the thorax being moved up and down in the vertical plane to produce the sound.

In walking the beetle stands high upon its legs and holds its antennae in front of the head, alternately tapping the ground with them after the fashion of ants. These antennae are undoubtedly used as sensory organs of one kind or another. The insect sits low when at rest on the trunks of the trees. It usually takes refuge in the daytime in old larval borings or its own exit-holes which have weathered or rotted on the exterior of the trunk under the influence of the climate. The grey silky colouring of the wing-covers gives it a wonderful resemblance to the bark of white poplar trees, and this undoubtedly serves as a protection to it, rendering it difficult to pick out on the trees at any distance. It is this great resemblance which would seem to give additional force to the argument that the insect's original food-plant was this tree.

The trees reported to date as infested by this beetle in Baluchistan are the white poplar (*Populus alba*), *raemar* poplar (*P.* sp.),

FIG. 213.—Portion of a willow-stem with the bark fallen off in places, exposing the attacks of the grubs of *Æolesthes holosericea.* Quetta.

Euphrates poplar (*P. euphratica*), Kandahar willow (*Salix alba*), weeping willow (*S. babylonica*), chinar (*Platanus orientalis*) (only slightly), and the elm (*Ulmus* sp.). The black poplar, Kabul willow (*S. aemophylla*), ash, mulberry (*Morus alba*), apricot (*Prunus armenica*), horse chestnut (*Aesculus indica*), and robinia (*Robinia pseudo-acacia*) were not attacked by the beetle.

Damage done to the Tree; Methods of detecting it.

The two stages in the life of this pest during which actual damage is done to the tree are the beetle and grub ones. Wounds, such as those made by lopping branches, abrasions during storms, etc., are taken advantage of by the female beetles for laying their eggs in. Failing fresh wounds on the bark, the beetle has to bore through the trunk down to the sappy portion of the bark in order to deposit her eggs in a position to ensure there being an abundance of soft food for the young larvae on hatching out. After feeding upon this for a period, the grubs, as they become older, work their way into the bast and sapwood of the tree, subsequently proceeding down into the wood to pupate. It is in the former stage of its life that the insect effects the greatest damage to the tree. An examination of many trees in Quetta in 1905 showed that owing to the feeding of the grubs beneath the bark the larger part of the green bast is eaten away by the larvae. Now, if the grubs are at all numerous in the tree, these eaten-out patches gradually join all round the stem, and the result is that the tree is ringed and dies. Even with the insects as plentiful as they were in Quetta between 1900 and 1905 the trees took some time to die, and this must be attributed to the fact that the beetles will lay their eggs on any part of the stem from the base up to the crown, in fact as high as there is a sufficient thickness to ensure there being a sufficiency of wood for the insect to bore into to form its pupal chamber. Owing to this fact, it takes longer for the patches eaten out by the larvae to coalesce all round the stem in one band, and the tree only dies slowly, as is shown in the case of the willow depicted in pl. xxi. At first sight this prolongation of the life of the tree might be considered an advantage, since it gives time for the growth of others to replace it. In reality, however, the position of affairs is very different. Trees so infested merely serve as centres of infection for neighbouring unattacked trees, and the insects will go on laying in them until the trees have arrived within a year of death. No beetle will then oviposit in them, since an abundance of fresh sappy bark and wood is essential for the grub's food. Cutting out dead trees, therefore, has absolutely no effect one way or the other in mitigating the damage done by the pest.

The detection of infested trees is comparatively simple.

(a) *Seriously Affected Nearly Dead Trees or Dead Trees.*—These are easily recognized. Large areas of the bark will have fallen away, disclosing the wood beneath deeply scored with the galleries of the larvae, some of which may be still filled with the large masses of chewed wood and fibrous excreta. If this latter has already fallen from the galleries, the pulling off

A living willow-tree infested by the grubs of *Æolesthes sarta*, Solsk. The numerous larval galleries in the sapwood are visible where the bark of the tree has fallen away. Quetta, 1905.

of another portion of the bark will disclose masses of it *in situ* in the galleries; from one portion of the gallery a hole will be seen proceeding down into the wood, and if this is traced downwards the empty pupal chamber will be found.

(b) *Trees Less Badly Attacked, but which will Eventually Die under the Attacks.*—Holes and small rotting areas on the bark, often at the junction of branches with the main stem, are visible, and, below these, exudations of sap, either fresh and trickling or dried to the bark beneath the hole. These exudations are usually in large irregular masses, tailing off below into thin trickles, the sap having dried on its way down the stem. Pl. vii shows a heavy outflow of sap down a poplar-tree. If some of these holes with the fresh exudations trickling from them are cut into towards the end of May and commencement of June and examined carefully, they will be found to contain one or more little clusters of eggs placed on the edges of the bark and well down in the sappy inner portion of it; later on in June numerous young larvae may be found here. If examined later in the summer, the careful paring away of the bark will disclose the grub in its half-formed gallery which grooves both the inner bark and sapwood. If holes on which the exudation has dried but is still fresh are cut into, they will show (provided they are not merely the old exit-holes of the beetle, when they may or may not disclose other insects, depending upon whether female beetles took advantage of them to lay eggs in) one of the following stages: if cut into in the autumn, the grub will be found nearly three-quarters or more grown, having nearly completed its sapwood gallery; later on in the winter the grub will be found to be boring its tunnel down into the wood, or quiescent, hibernating for a part of this period; late in May it will be necessary to cut right down into the wood, when the grub will be found in the interior in, or making, its pupal chamber.

If the exudation below the holes is dry and old-looking, an examination of them will disclose in the autumn the pupae in the pupal chamber in the interior of the wood, in the winter about January or February the fully formed but still soft beetle in the same position, and about the beginning of April the fully formed beetle commencing to make or engaged in making its way through the layer of wood and bark or up the larval tunnel, or no insect at all, but merely this exit-tunnel, if the galleries are more than two years old.

(c) *Trees but Slightly Attacked.*—These may show only one or two holes or patches of sap exudation, but according to the appearance of the latter and the time of the year it will be quite possible to form an accurate estimate of the stage arrived at by the insect in them.

Protection and Remedies.

The life history shows that the beetle seeks out wounds on the trees it affects in which to lay its eggs. It follows, therefore, that all wounds made in trees at the egg-laying period are so many facilities to the beetle in her egg-laying operations. Since she lays her fifty eggs in clusters of about ten, failing wounds in the trees she has to bore out small areas herself in which to

deposit them. If the sap does not flow freely at these places it is obvious that a high proportion of the young larvae hatching out will die before reaching the bast layer. In the case of a large wound the majority will probably reach it with facility, and mature into full-size grubs and eventually into beetles. Observations have shown that it is probable that the most critical period in the life of this hardy insect is the initiatory stages of the larval life.

It is therefore of the first importance that trees, whether grown in gardens and avenues, or in copses and groves, should not be pruned or lopped in the springtime. If pruning is necessary it should be done in the autumn and winter, after the wood has ripened, and the pruned surfaces be thickly coated with tar.

If trees are blown down or branches broken off in the spring, under the devastating effect of high winds and storms, they should, in the first instance, be cut up and removed at once; in the second, the point at which the injury has taken place should be carefully trimmed and a thick coating of tar be applied to it. In the case of garden and avenue trees injuries to the bark between the end of March and end of June should be immediately given a thick coat of tar. All infested trees form so many centres from which the beetles maturing from them will carry on the infection to trees as yet unattacked. Therefore such trees should be felled in the autumn and cut up and burnt, or the material converted into charcoal during the ensuing winter.

Trap Trees.—These are trees which are selected to serve as lures for the insect to lay in, the intention being that they should subsequently be removed, cut up, and burnt as soon as they are full of larvae and pupae. The selection of such trees depends upon circumstances, and whether they are required for the protection of trees in a garden, avenue, or plantation. In the great attack of *A. sarta* on the Quetta avenues between 1900 and 1907 so many of the trees were found to be infested in 1905 that the selection of trap ones to leave over the following year was a comparatively easy matter. Ordinarily the selection would be more difficult, but in the case of an attack the partially infested trees should be selected, for additional beetles will resort to them in the following year, as plenty of bast still remains unattacked. Very badly infested trees should be cut out, cut up, and converted into charcoal.

Should all the trees infested be in a very bad state they should be removed in the autumn, and a tree or two be partially (not totally) ringed so as to lower their vitality and reduce them to a moribund and sickly condition. The beetles issuing the following spring will resort to these trees to oviposit, and the trees will then be felled and removed, as already prescribed, in the following autumn.

That the removal of infested trees in the autumn and their conversion into firewood or charcoal during the winter will stamp out an attack of this pest has been abundantly proved in the case of Quetta, where the appalling

state of affairs as existing in 1905 is entirely a thing of the past, the beetle being now almost scarce in the station, whereas it existed in thousands in the year mentioned.

If infested timber is converted into firewood, the fuel must be utilized during the winter of its conversion. If allowed to remain in store during the following spring mature beetles will issue from it and carry on the attack.

Æolesthes sp. prox. aurifaber, White.

REFERENCE.—*Ind. Forester*, xxxiv, 216.

When investigating the attacks of what was known throughout Burma as the "Bee-hole Borer of Teak" in the Mohnyin Forest in Katha the Deputy Ranger and myself took a large number of longicorn larvae from a green teak-tree which had been attacked by the Bee-hole borer (*Duomitus ceramicus*). The grubs I noted resembled either *Æolesthes*, *Plocæderus*, or *Hoplocerambyx* ones. They were feeding in the bast and sapwood in considerable numbers. Some had already bored down deeper into the wood to pupate. This was on 24 February 1905. I could find no pupae or mature beetles.

Mr. T. A. Hauxwell, Conservator of Forests, Pegu Circle, took, in 1908, a specimen of a longicorn beetle issuing from a hole in a teak log which was being squared in a Rangoon mill. This log was found to be badly bored. The insect was dispatched to Mr. C. J. Gahan at the British Museum, and by him identified as a species of *Æolesthes* closely related to *aurifaber*, but whether distinct or not it was impossible to say without a specimen of the female insect.

Teak is, as is shown in this chapter, tunnelled into by several longicorn beetles, but the work of a longicorn larva is very easily distinguishable from that of the caterpillar of a moth. There is of course no connexion or similarity between these tunnels of the Cerambycidae in teak and those of the true "Bee-hole borer" *Duomitus ceramicus*, the author of the "bee-holes" in teak logs which have been known for well over a century.*

MASSICUS.

Little is known upon the importance of this genus in the forest. The credit for observations so far carried out belongs to Mr. H. W. A. Watson, I.F.S.

Massicus unicolor, Gahan.

REFERENCE.—Gahan, *F.B.I.* Ceramb. vol. i, no. 129, p. 130 (1906).

Range.—Southern Shan States (Taunggyi). Gahan gives in the *Fauna* Assam; Patkai Mountains (Doherty).

Tree Attacked.—Oak (*Quercus griffithii*). Taunggyii (H. W. A. Watson).

* Vide my "Note on the Bee-hole Borer of Teak in Burma," *Ind. For. Bull.* no. 1 (1905). Govt. Press, Calcutta.

Description.

Beetle.—A large stout beetle. ♂ blackish brown, covered all over with short pubescence of a uniform greyish tint. Antennae not quite twice length of the body, the first joint short and thick, not reaching to the front margin of the prothorax, sharply edged, and angulate in front at the apex; third half as long again as the first, and strongly thickened from the middle towards the apex; fourth sub-equal in length to first, thickened less strongly than third; fifth larger than third, and shorter than sixth; sixth to eighth sub-equal in length; ninth and tenth shorter; eleventh nearly twice as long as tenth; sixth to tenth angulated at the apex in front, unarmed posteriorly. Prothorax somewhat rounded at the sides, constricted a little behind the apex; marked with one transverse furrow near the apex, and with two near the base, the whole of the upper surface between the grooves coarsely and irregularly corrugated. Elytra transomely truncate at apex, with the outer angles obtuse, and the sutural ones spined.

♀ smaller than ♂ with shorter antennae, with differences in the sculpture of the prothorax. Length, 55 mm. to 63 mm.; breadth, 15 mm. to 18 mm. Fig. 187 shows the ♂ beetle.

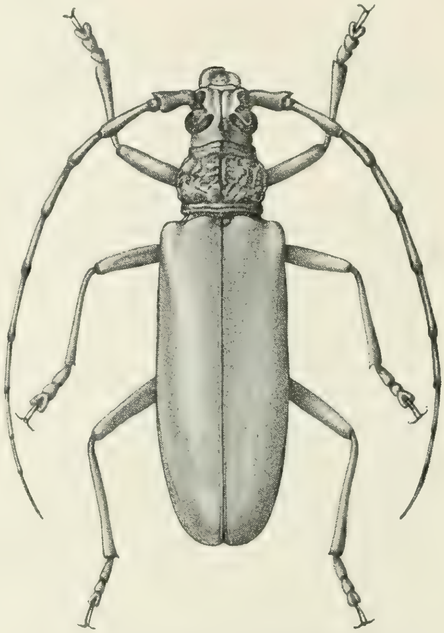


FIG. 214.—*Massicus unicolor*, Gahan. ♀. 1/1. Southern Shan States.

Larva.—A long, stout, cylindrical, corrugated grub, ivory white in colour. Length, about 65 mm. The larva shown in fig. 215 is much shrunken.

Pupa.—Large, stout, yellowish in colour, with a prominent head and prothorax, the long thick antennae and legs pressed against the sides and chest.

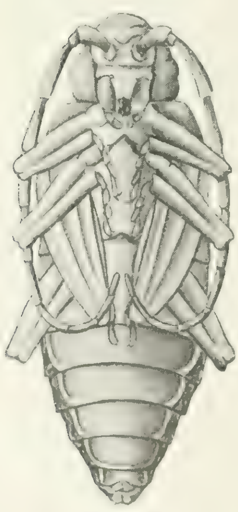


FIG. 216. Pupa of *Massicus unicolor*, Gahan. 1/1

FIG. 215. Larva of *Massicus unicolor*, Gahan

Life History.

The fact that this insect lives in green oak-trees in the Southern Shan States, at about 5,000 ft. elevation, was discovered by Mr. H. W. A. Watson, I.F.S., the Divisional Forest Officer, in 1907, and all that is at present known of the life history of the insect is due to his careful and untiring investigations. His observations, which he considers require further careful verification, are as follows:—

"Fertilization takes place apparently in the tunnels. One ♀ of those sent contained about fifty large eggs.

FIG. 217.—Galleries of *Massicus unicolor*, Gahan, in the heart-wood of *Quercus griffithii*. Southern Shan States.

"I cannot make out where the eggs are laid. Beetles appear in September, and apparently the eggs are laid at the end of the month.

"Larval stage—at least two years. Pupal stage—about six weeks.

"Larvae in wood in my house" (Mr. Watson cut some large sections of trees containing larvae, and kept them in his house under observation) "pupated about end of July or beginning of August, and beetles were found beginning to middle of September.

"Larvae pupate at end of tunnel, stopping up the tunnel with sawdust, more or less cemented together apparently with saliva.

"The larvae make a distinct noise when tunnelling, and eject large quantities of sawdust.

"The larva moves apparently up and down its tunnels, which are elliptical in shape, and fully $1\frac{1}{2}$ in. by $\frac{3}{4}$ in. in section" (cf. fig. 217).

"Mature beetles seem to skulk a lot in the old tunnels."

In reporting this insect, Mr. Watson wrote :—

Damage Committed in the Forest.

"I am sending you a specimen of a beetle larva that appears to do a lot of tunnelling in green oak wood in Taunggyi. When inspecting newly erected posts round the fuel reserve here, I noticed one oak post (from a freshly felled green tree) to have several holes in it from which sawdust was being ejected, and had part of the post cut off and brought to me. In it were three of these larvae. The two others are still living in the piece of wood. They have now been in my house some three and a half months, and as yet show no signs of pupating."

This note was written on 14 November 1907. The observations were carried on up to the middle of June 1909, with the excellent results detailed above.

Hoplocerambyx.

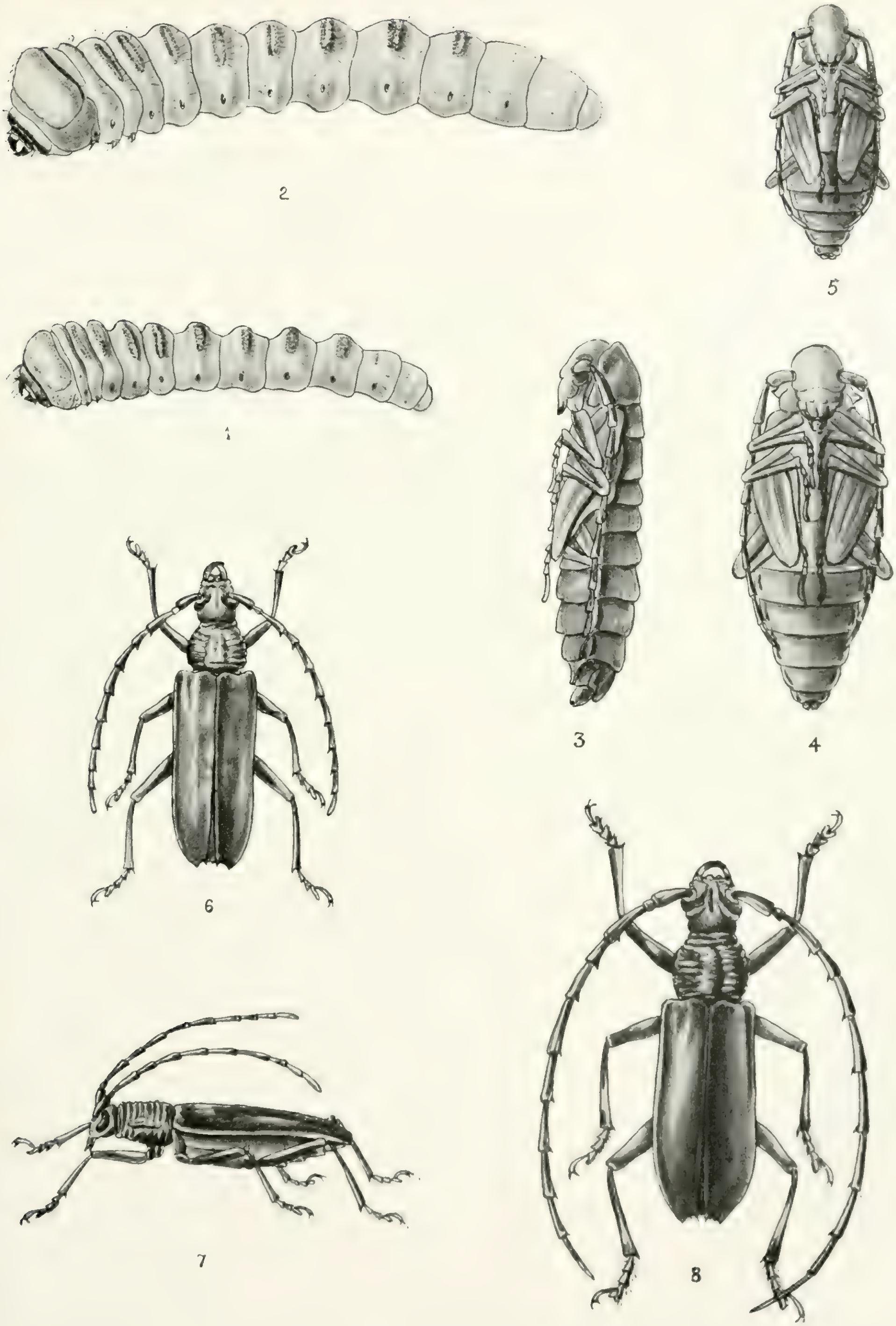
Only one Indian species of the genus is known. It is one of the most pernicious of the sál-tree pests of the Central Provinces, Chota Nagpur, Eastern Bengal, and Assam.

Hoplocerambyx spinicornis, Newman.

References.—Newman (*Hammaticherus*), *Entom.* i, p. 245 (1842); *Cerambyx ? morosus*, Pascoe, *Trans. Ent. Soc.* (2), iv, p. 92 (1857); *Hoplocerambyx relictus*, Pascoe, *P.Z.S.* 1866, p. 528; *Hoplocerambyx morosus*, Pascoe, *Trans. Ent. Soc.* (3), iii, p. 515 (1869); Stebbing, *Inj. Ins. Ind. Forests*, p. 71 (1899); Ibid. Note on Life Hist. of *Hoplocerambyx spinicornis*, *For. Bull.* no. 8 (1906); Ibid. Some Assam Sál (*Shorea robusta*) Pests, *For. Bull.* no. 11 (1907); Gahan, *F.B.I.* Ceramb. 131 (1906).

Range.—Central Provinces, Chota Nagpur, Kusunda (Bengal Coal Fields), Bengal Terai and Duars, Eastern Bengal and Assam, Southern Shan States.

PLATE XXII.



Hoplocerambyx spinicornis, Newn.—1, 2, larva, two-thirds and full grown; 3, 4, 5, female pupae; 6, 7, female beetles; 8, male beetle. Central Provinces and Assam.

Gahan in the *Fauna* gives Allahabad, Nepal, Assam (E. P. Stebbing), Tenasserim, Thagaea (Fea), South Afghanistan, Penang, Singapore, Sumatra, Borneo, Philippine Islands.

Trees Attacked.—Sál (*Shorea robusta*) : Central Provinces, Chota Nagpur, Bengal Coal Fields District, Bengal Terai and Duars Sál Areas, Eastern Bengal and Assam Sál Areas ; *Duabanga sonnatioides* and *Pentacme suavis* : Taunggyi, Southern Shan States (H. W. A. Watson).

This is one of the most remarkable of the Indian forest longicorn beetles. It is the only known Indian representative of its genus, has a very wide habitat, occurring throughout the sál areas of Central and Eastern India and in other trees in the Southern Shan States, and commits very serious depredations in the forest. A most curious feature in connexion with the range of the insect is the fact that it appears to be absent from the United Provinces and Oudh sál forests, where its place is taken by the longicorn *Æolesthes holosericea*, which, as has been shown, is a serious pest in these areas. I have not taken this latter beetle in sál in any locality where the tree is infested by *Hoplocerambyx spinicornis*. The first record of the latter as a pest of the sál-tree appears to have been made by myself in 1897. During that year it was taken in numbers from logs and newly converted green sál sleepers in the Singhbhum Division in Chota Nagpur.

Description.

Beetle.—A narrowish elongate black or brown-black longicorn, with a prominent projecting head and long antennae. The elytra vary in colour from piceous to reddish brown. Light-coloured red beetles are immature insects taken from the pupal chambers before the outer parts have hardened and darkened to the normal colour. Head, prothorax, antennae, legs, and under-surface are covered with a fine greyish pubescence ; the elytra are more densely covered with a silky yellowish grey pubescence, which alters as the light falls upon it at different angles. Head with the eyes separated above, the space between being deeply grooved. Antennae of males longer than body by a fifth to a third of their length, according to the size of the individual ; antennae of ♀ shorter than body. Prothorax longer than broad, the disk with a slightly raised oblong space in the middle, the rest of the surface strongly transversely wrinkled, the ridges broken at sides. Each elytron obliquely truncate at the apex, with a spine at the suture, and a small tooth at the outer angle. The beetle varies remarkably in size (cf. fig. 32), specimens varying in length from 20 mm. to 63 mm. ; breadth, 5 mm. to 17 mm. In pl. xxii, figs. 6, 7 show the ♀ and 8 the ♂ beetle.

Egg.—The freshly laid egg is elongate, cylindrical, slightly swollen at the anterior end ; white, opaque, shining, with blunt rounded ends. Length, ⅛ in. The egg-shell is white and of a papery-like consistence (fig. 218, *a*, *b*).

Young Larva.—The newly hatched grub is about ⅛ in. in length, yellow, shining, thickest anteriorly. (See fig. 218, *c*, *d*.)

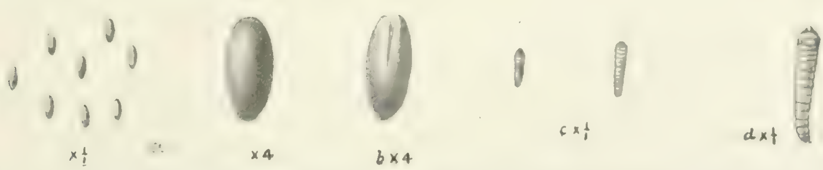


FIG. 218.—*a*, Eggs of *Hoplocerambyx spinicornis* natural size and magnified (one) ; *b*, empty egg-skin ; *c*, young larvae ; *d*, larva four to five days old. Assam.

Larva.—Elongate, tubercular, with a squarish section, consisting of the head and twelve segments. Head black, transverse, with powerful mandibles. The segment following the head (the prothorax) is greatly enlarged, dark yellow in colour, with a dorsal shining plate of thicker consistency than the rest of the body; the following two prothoracic segments are narrow. They and the other nine segments of which the body is composed are yellow in colour. There are two prominent elevations or tubercles placed transversely on the dorsal surface of segments 4 to 10 inclusive. The twelfth segment tapers to a blunt point behind. There are a pair of minute legs on each of the thoracic segments, and a pair of short sucker-feet on each of the segments 4 to 10, being most prominent on segments 7 to 10. Length of full-grown larva, $3\frac{1}{2}$ in.; size variable. In pl. xxii, fig. 1, 2 show a two-thirds grown and fully grown larva.

Pupa.—Whitish yellow in colour. Exhibits the form of the perfect insect in part. The head is, however, pressed down upon the upper part of the chest, upon which, below it, are folded the legs and the rudimentary wings, the latter being curved round so as to lie in this position. Seven abdominal segments are visible on the dorsal surface of the nymph. The antennae are curved backwards, and lie pressed against the sides of the insect. Length, 2 in.; variable in size. In pl. xxii, fig. 3, 4, 5 show side and ventral views of female pupae.

Life History.

Of such importance is this beetle in the sál forests of the country that I have deemed it expedient to give here in full the life history of this insect as it has been ascertained, with the valuable and untiring help of Mr. W. F. Perrée, I.F.S., and one of his Range Officers, Mr. Rama Nath Mukerjee, for Assam; and with the assistance and observations of Mr. C. P. Percival, I.F.S., in the Central Provinces. The careful and systematic investigations carried out by these officers in the course of their ordinary divisional duties have proved, if indeed such proof were necessary, how greatly executive officers can assist in the study of the forest insect pests of the country. The work done also shows how essential it is that the Provincial and Ranger classes should have a thoroughly sound knowledge of economic forest zoology.

Life History in Assam.

The life history of this insect in Assam, as detailed in my monograph on *Some Assam Sál Insect Pests*, will be first considered. The Assam area may be taken to include Assam, the Bengal Duars and Terai sál areas, and adjacent sál tracts in Nepal.

Appearance of Beetle on the Wing.—This beetle was exceedingly plentiful in the Kachugaon forests of the Goalpara Division in the latter half of May 1906. Mr. Perrée is of opinion that it first begins to appear towards the end of March or beginning of April. It is present in the forests all through June, but begins to get scarce in July, as proved by the observations made by Rama Nath Mukerjee after my departure from Goalpara at the end of May. He kept some careful enumerations by felling trees to attract the beetles. I shall allude to these later on.

I cannot at present say whether this insect is again found on the wing in Assam later on in the year, but I think it is just possible that it may appear again in September–October. Immature specimens of the beetle were taken from the pupal chambers in green standing trees in the Apalchand Range, Jalpaiguri Division, in November.

Instinct of Beetle.—The beetles are gifted with an instinct which enables them to seek out unerringly newly felled or standing trees in the forest in the condition they require for oviposition. This can easily be proved by felling a green tree in the forest. One such felled on 13 May was inspected next morning, and a large number of both male and female beetles were found on the lower side of the bark between the trunk and the ground.

Pairing and Egg-laying.—The male seeks the female in such places and pairs with her on the bark of the tree. It has been noted that the insects vary greatly in size, but this fact appears to be immaterial in the pairing of individuals, a small male pairing with a large female or *vice versa*. Opportunities occurred of watching the insects *in coitu*, and the procedure is rather curious. The male insect mounts on to the back of the female, and oviposition alternates with the act of fertilization. The penis of the male is hard and horny, very long, and curved scimitar-shape backwards and downwards. The actual act of pairing appears short. The female possesses a long, flat, bluntly-pointed, tapering, telescopic ovipositor about half an inch in length and brown in colour. With this she deposits her eggs here and there in crevices in the bark or on the flakes of bark. The ovipositor is very flexible, and is used for groping and searching out suitable places for oviposition.

Position where Eggs are Laid.—The eggs, which evidently develop very rapidly in the ovisac, are laid singly, and are scattered about in a most erratic manner. The female appears to choose preferably moist sappy areas of bark on the lower sides and under-side of the fallen trees, or on the shady side of standing ones; but eggs are also to be found in dry crevices and on the outer surface of dry bark, or amongst short wet moss on the bark. They are found most numerously, however, in the moist bark areas. She will also deposit them on the upper surface of the bark of felled stems and on the sunny side of standing trees in dull weather, and very little attention appears to be paid to the actual site chosen for deposition. I have even found them forced down the entrance-holes of the *Sphaerotrypes* bark-boring beetle in the bark. Pairs *in coitu* were watched. The female walked slowly over the bark, laying an egg here and there at intervals, and in the intervals the insects paired. It was thought that the beetles commonly laid eggs in the sleepers or on barked logs, but although young larvae have been found in both I do not think it has been yet proved that, as a general rule, the eggs from which they hatched had not been previously laid in bark which was subsequently removed. Mr. Rama Nath Mukerjee took in June some eggs on newly converted green sleepers, and I myself found some small larvae two weeks or so old in logs brought out shortly before to the forest tramway.

Number of Eggs Laid.—I have not yet been able to ascertain the number of eggs laid by a female. Some countings were, however, made to ascertain the number of eggs laid on a tree. On a 15-ft. strip of bark taken round the whole circumference of a newly felled tree 150 eggs were laid between

the night of 14–15 May and the 19th of the month, or 6,000 eggs on a 55-ft. bole.

Number of Beetles Laying in Trees.—Eggs were laid subsequently to this date. From this tree, which was felled on the 14th, 54 beetles were taken on the 15th and 40 beetles on the 19th.

Mr. Rama Nath Mukerjee kindly carried on these observations until 17 July, and submitted the following interesting note :—

PERIOD AT WHICH BEETLES BEGIN TO DISAPPEAR FROM FOREST.

Result of inspection of sál-trees felled for the purpose of determining at what periods of the year the longicorn beetles are to be found on the wing.

Sál-tree No. 3.—Green, blown down by storm on 29 May 1906. Girth, 5 ft. 4 in. Length, 50 ft. Forked at a height of 21 ft. ; stem full of knots, all the roots (except few small side ones) were found to have been attacked by fungi. There was no other external sign of disease.

30 May 1906.	Beetles found . . . . . 606 { at 7 A.M. = 207, ,, 10 A.M. = 189, ,, 4 P.M. = 210 }	
	Some eggs were found on the stem.	
31 ,, ,,	Beetles found	19
1 June ,,	,, ,, ...	7
3 ,, ,,	The eggs collected on 30 May 1906 were found to have hatched in the tube.	
4 ,, ,,	Beetles found	15
	Total beetles found on tree No. 3	647

Sál-tree No. 4.—Green, felled 8 June 1906. Girth, 4 ft. 3 in. Length, 61 ft.

9 June 1906.	Beetles found	228
10 ,, ,,	,, ,, ...	24
13 ,, ,,	,, ,, ...	9
	Total . .	261

Sál-tree No. 5.—Green, felled 20 June 1906. Girth, 4 ft. 5 in. Length, 61 ft.

21 June 1906.	Beetles found	128
22 ,, ,,	,, ,, ...	47
23 ,, ,,	,, ,, ...	21
25 ,, ,,	,, ,, ...	20
26 ,, ,,	,, ,, ...	9
9 July ,,	,, ,, ...	8
	Total . .	233

Sál-tree No. 6.—Green, felled 8 July 1906. Girth, 4 ft. 3 in. Length, 72 ft.

9 July 1906.	No beetles were found.	
10 ,, ,,	,, ,, ,, ,,	
16 ,, ,,	,, ,, ,, ,,	
17 ,, ,,	Beetles found	4

In November 1905 Ranger Rakhal Das Chakravarti reported that he had discovered longicorn grubs tunnelling into living sál-trees, "trees of 5 ft. in girth having completely succumbed on account of their attack." These grubs were collected on 6 November. A fortnight later the ranger

took some immature living beetles from the same locality. They proved to be *H. spinicornis*.

Trees Chosen for Egg-laying.—The beetles invariably choose newly felled or green sickly standing trees in the forest for egg-laying. An inspection in May 1906 of some large trees felled in the preceding February, and still lying unbarked in the forest, showed that no fresh eggs had been laid on the bark, although the sapwood contained young larvae. Trees which are being suppressed or slowly strangled by heavy creeper growth are apparently often chosen for egg-laying purposes.

Habits of Beetle.—The beetles fly at night. In the daytime they hide either beneath the bark of newly felled trees, large numbers being invariably found here in the last fortnight of May 1906, or in the undergrowth in the forest. More rarely they are found in interstices of the bark of standing trees, their coloration approaching that of the sál bark. They are powerful fliers, and probably travel a considerable distance in search of suitable trees. During a heavy storm one night numbers of beetles were blown from the forest about four miles distant into the veranda and rooms of the Kachugaon Bungalow; in this way they probably get dispersed over large areas. The incident proved that the beetles are sufficiently powerful to fly at night in heavy wind and rain.

Hatching out of the Grubs.—The small grubs hatch from the eggs within five to eight days after oviposition. In hatching the egg-shell splits longways

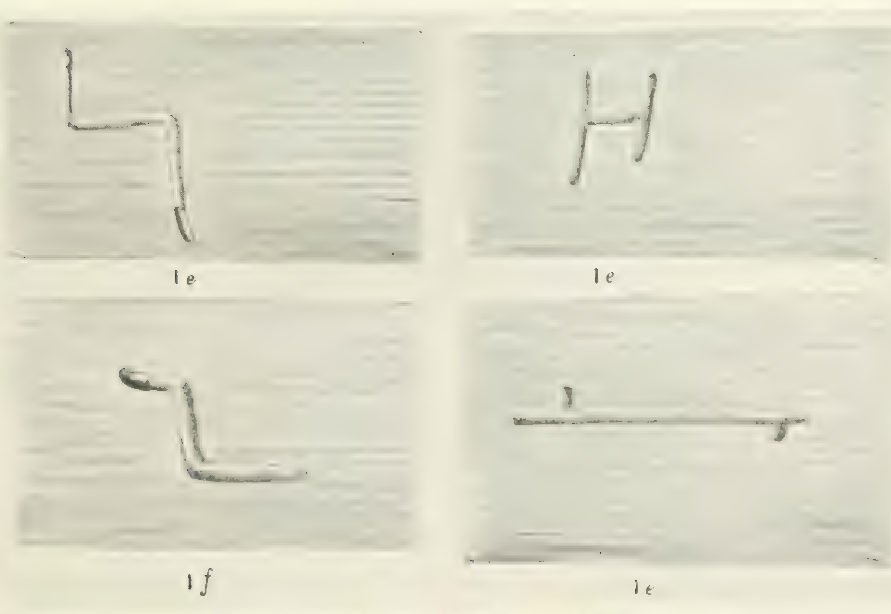


FIG. 219.—Galleries of young larvae four to five days old of *Hoplocerambyx spinicornis* in the outer surface of sál sapwood. Assam.

down one side (fig. 218, *b*). The newly hatched grub is about an eighth of an inch in length. A green tree free from the insect was felled on the 13th. It was at once attacked (on the night of 13th–14th) by the beetles, and on the 23rd was full of young larvae a few days old, whilst others were just hatching out. The largest found was a quarter of an inch in length, and probably four to five days old (fig. 218, *d*). This larva was taken from the gallery shown in fig. 219, 1*f*. Others are shown in 1*e*. Unlike the larva of many longicorn grubs, this one does not spend any time feeding in the bast, but at once bores straight down through it to the sapwood and commences to bore an irregular shallow gallery in this latter. This gallery is at first narrow, and consists of two or more arms (fig. 1*e*). It is entirely packed with the wood excreta ejected by the larva, the only free space in it being that occupied by the body of the grub.

Life History of Larva.—The larva spends its whole life feeding in the wood, remaining in the sapwood until it has attained full growth. It is to be found in the larger roots, main stems, and in the larger branches of the crown of the tree. It bores large irregular galleries here which are invariably blocked with wood refuse. In these operations the cambium layer is usually completely destroyed (cf. pl. xxiii). The grub has evidently a very rapid growth when in favourable situations as regards food supply. This is proved by the fact that larvae evidently hatched out during the year were found over an inch in length early in May. In the damp heat of the Assam climate eight to nine months would appear to be the maximum time usually passed by the larva in this stage of its existence, and the period may perhaps be much shorter, not exceeding five months. Its work in the tree, performed at a greater rate, is of a similar nature to that of the insect in the Central Provinces, and it pupates in the same way by boring down into the heart-wood and eating out a pupal chamber in the long axis of the tree.

I came across several instances of trees felled in February 1906 which contained larvae at least half-grown in the latter part of May. The explanation is to be found in either of the two following suppositions:—

(*a*) The beetles appear more than once in the year, winged beetles making their appearance in the autumn months, although there is no true second generation, the insect taking a year to pass from egg to beetle.

(*b*) The grubs spend the cold weather hibernating in the pupal chamber in the heart of the tree, the period of feeding being in the one case from March to about November, by which time they are full-grown; in the other from June to March and March to June, when they would pupate. As a matter of fact larvae were found in the heart of logs, or on their way there, in the latter half of May. These may issue as beetles about the middle of July, or perhaps later.

Plates xxiii and iv show the work of the grubs in the sapwood and some larvae and beetles in the pupal chambers in the heart-wood of a log. The curious white calcareous coverings made by the larvae so as to close the

W. F. Perree, photo.

Portion of the trunk of a sál-tree showing the work of the grubs of *Hoplocerambyx spinicornis*, Newn., in the bast and sapwood. Living larvae are seen *in situ* in the galleries. Goalpara, Assam, 1906.

pupal chamber against the attacks of predaceous foes are also well shown in the latter plate. The illustrations are from photographs taken in May by Mr. W. F. Perrée of a green tree felled in the forest in February 1906. Both boring grubs and one or two beetles just ready to emerge were found in it; also some pupae taken from the wood in April 1906. To ascertain the number of larvae which reached maturity, I examined on 30 May a green tree felled near Rajabhatkhowa on 15 February. From a circular section of a log 15 in. long, taken midway up the length of the bole, 60 grubs of various sizes up to apparently nearly full-grown were cut out, this number giving 2,840 grubs in the 55-ft. bole of tree. The tree proved a fair example of a badly attacked one. Larvae examined when boring down into the heart-wood and excavating the pupal chamber were found to contain in their bodies a large amount of a peculiar white substance doubtless secreted by them for the purpose of preparing the white calcareous covering to the pupal chamber.

The Pupal Stage.—Pupae have been taken from the pupal chambers in the heart-wood in February (on the authority of the Range Officer), and one which is probably this insect on 28 April. I think it possible that the insect pupates about February in the case of the beetles issuing in May–June; but in the case of those issuing in March it would probably pupate in November, and for those issuing in the autumn (if any do so) in May–June. The pupal stage is probably two to three months, varying according to the time of the year when the larva pupates.

The Beetle.—The insect on assuming the beetle form remains in a resting condition in the pupal chamber, whilst the outer parts slowly harden. It then breaks the calcareous covering, closing the mouth of the pupal chamber (*vide* pl. iv), and makes its way up the broad larval tunnel in the heart-wood, which is always free of wood particles, since whilst boring it the grub probably feeds little and ejects from it the wood particles gnawed out, pushes or gnaws its way out through the mass of wood refuse in the broad larval galleries in the sapwood, and bites its way out through the bark, the escaping orifice always being a large one.

The beetles invariably appear to leave the tree at night. Careful inspection has never disclosed the fact of any beetle boring or pushing its way out in the daytime. There seems, however, to be little doubt that the beetles, although they do not take wing readily, are active on cloudy, dull, rainy days, and that they pair a good deal in dark shady places in the forest during the daytime.

Life History in Central Provinces.

The observations carried out on the life history of this insect were commenced in Chota Nagpur in 1897, when it was first discovered as a pest of the sál. The larva was found and the approximate date of pupation and the dates of emergence of the beetles in considerable numbers in May and June were ascertained.*

* *Injurious Insects of Indian Forests*, 71 (1899).

These observations were much augmented by Mr. A. P. Percival, I.F.S., in Balaghat in 1905. Mr. (now Sir Sainthill) Eardley Wilmot, Inspector-General of Forests, during a cold-weather tour in Balaghat had noticed some fine large green sál-trees dying under the attacks of an insect. The trees were suffering so severely that the infestation was considered to be of serious importance, and instructions were issued that an investigation should be carried out at an early date. The result of Mr. Percival's observations very materially forwarded our knowledge of the life history of *Hoplocerambyx* in the Central Provinces, and I published them in *Forest Bulletin No.* 8.* Both here and in my short notes published in *Injurious Insects*, it was considered that the grub spent more than one year in this stage of its existence. The beetle was thought to first appear on the wing at the end of May and chiefly in June. The eggs had not been found.

In April and May 1909 I toured in the Mandla district adjacent to the Balaghat forests, and had the opportunity of studying further the habits of this interesting longicorn. As a result of my investigations, during which I took the beetle ovipositing and found numerous eggs, it has become necessary to modify the opinion that the larva spends more than a year in this stage of its existence, and that consequently the life-cycle takes over a year to pass through. In Assam we have seen that it is possible that the insect may pass through two, or nearly two, life-cycles in the year, i.e. that an autumn generation of beetles may issue, their offspring issuing probably in the following July. In the very hot damp climate of Assam the larva would doubtless develop quicker than in a hot dry one. In the Central Provinces no beetles appear on the wing in the autumn; but the first beetles of the year appear early in April, and in the third week of the month they are to be found egg-laying in the forest. Thus the fact would seem to be established that in this part of the country the beetles are to be found in the forest, and that consequently eggs are laid in the trees in the forest, between the middle of April and about the middle of July, or approximately during a period of three months. This would account for the difference in the size of larvae found in the trees. That this is the case is, moreover, borne out by the fact that an examination of infested trees in Mandla in April in no case brought to light young larvae. Very few old ones were visible, and they in every case full-grown. The bulk were at the time down in their pupal chambers in the heart-wood of the trees, either in the form of pupae or as immature or mature beetles. We will now glance at a few of the other differences of the life history of the insect in the Central Provinces.

Egg-laying.—The beetle here lays its eggs on the outer bark and in the crevices, as is its habit in Assam. It appears, however, invariably to lay

* Note on the Life History of *Hoplocerambyx spinicornis*. *For. Bulletin* no. 8 (1906).

them on the under-side of fallen trees and on the north side of standing sickly trees with the object of safeguarding them from the hot rays of the sun, which are very fierce at this season of the year.

Larvae.—The fact that comparatively young immature larvae have been found in the wood in November may be due to their having originated from the eggs laid by the late July beetles. The grubs probably usually pass the winter in the heart-wood in their pupal chambers, or spend part of this period in eating out these pupal chambers. Those who completed the pupal chamber by February pupate and issue in April. The later ones pupate in March and April, issuing respectively as beetles in May, June, or July. In no case under ordinary circumstances are more than two months passed in the pupal stage. The period would appear to be usually six weeks, with three to four weeks in the resting stage as an immature beetle.

Investigations carried out in a number or sickly or dying standing trees and in some newly felled ones in the middle of April in the Banjar Valley in Mandla showed that there were practically no larvae to be found in the new large larval galleries in the bast and sapwood. The grubs had all gone deep down into the heart-wood to pupate, as was evidenced by the large orifice holes of numerous tunnels leading down into the wood. Beetles on issuing search for standing sickly or dying trees in the forest or newly fallen or felled ones. I examined a large number of the large trees which had been felled on the line of a broad new cart-road being driven through a portion of the Mandla forests at the time of my visit. The trees inspected had been felled three months or over; they were thus already to some extent dry on the outside, and the bark had lost a certain degree of moisture. In no instance could I find that the beetles then ovipositing in the forest had made use of these trees to oviposit in. Sickly standing trees and newly felled ones were found towards the end of April to have numbers of beetles on their northern or lower shady sides all pairing or egg-laying. This point that the young grubs require absolutely fresh sappy sapwood during the first few days of their existence has been established for the insect in Assam, and appears to be the rule in the Central Provinces. The practical outcome is that if it is required to fell and not bark timber to be left in the forest the trees should be cut at latest by the end of January.

Life History in the Southern Shan States.

In an interesting communication received in 1909 from Mr. H. W. Watson he reported that beetles which have been identified as this insect infest the trees *Duabanga sonnatioides* and *Pentacme suavis* in Taunggyi, Southern Shan States, the wood being riddled by the tunnels and pupating-chambers of the grubs. The life history of the insect in this locality has not yet been worked out.

Damage Committed in the Forest.

The damage committed by *Hoplocerambyx* in the forests is of a two-fold nature: (i) The grub feeds in and destroys the bast layer of the trees, thus eventually killing the tree; (ii) the grub tunnels down into the heart-wood and thus spoils or ruins it for commercial purposes.

The beetles, beyond enlarging the exit-holes in the bark to enable them to leave the tree, do no actual harm to it. The damage is of the same nature both in Assam and the Central Provinces and neighbouring sál areas. In both the insects must be regarded as a most serious pest.

Damage Committed in the Assam and Eastern Bengal Sál Belt.

It is probable that in Assam, owing to the hotter and moister climate, the life-cycle is shorter, and therefore the beetle increases with the greater rapidity. Also in Assam the creepers have a much more luxuriant growth, and tend to induce sickness and loss of vitality in the trees to a much greater extent, and thereby engender a state of growth particularly favourable to the attacks of the cerambyx. Observations would seem to show that this creeper growth is one of the greatest dangers the trees have to contend with in these forests. Not only is it in itself particularly harmful, eventually strangling the life out of the tree, but, if cut back too late, the tree has lost so much vitality that it falls an easy prey to both the longicorn beetle and the bark-borer *Sphaerotrypes* (p. 481).

Besides being a serious menace to the trees themselves, the beetle is equally noxious as a pest to the timber, and, unless barked, the wood of the trees felled in the forest will be found to be full of the larvae within two or three months. Both logs and sleepers examined in the Hultugaon and Kachugaon forests of the Goalpara Division and the sál areas round Rajabhatkhowa in the Buxar Duars Division were found to contain the tell-tale holes made in the wood by the larvae of this pest; and Mr. Perrée has informed me that the depredations of the insect are now so well known and are of so damaging a character that the most serious losses are suffered if barking is not undertaken at once.

I think it may be taken as proved that the beetle will not lay eggs in dead bark or even in bark of trees felled two or three months before it appears on the wing, nor will it lay in dry wood. That the beetle lays eggs in standing green trees was proved by Mr. Perrée himself showing me a tree of this description which bore evidences of being attacked by the beetle. Woodpeckers had bored circular holes into the bark in several places to get at the grubs or pupae (*vide* fig. 222). The tree had a girth of 3 ft., and the top was absolutely green. We felled the tree and split up the last eighteen inches of the stump above ground. In it were two full-grown larvae pupating in their newly constructed pupal chambers, each chamber being covered with a newly formed calcareous covering and having

a direct connexion with the outside. In another pupal chamber a mature beetle was found just ready to emerge. This latter was in the heart of the tree. Many beetles had evidently previously issued from this tree, the stump being riddled with pupal chambers right down into the crown of the roots.

Damage Committed in the Central Provinces and Chota Nagpur Sál Belt.

The beetle in the Central Provinces would appear to have a habit of destroying the trees in patches. It has been mentioned that Sir S. Eardley Wilmot's attention was drawn to its depredations in Balaghat by finding a group of fine large trees dying. In Mandla I noticed the same thing on several occasions. *Aeolesthes holosericea* has the same habit when infesting the sál in the United Provinces. Another serious aspect of the beetle's attack in the Central Provinces is that, as in Assam, it is accompanied and assisted by a species of *Sphaerotrypes* bark-borer (p 487) which I discovered seriously infesting the trees in Mandla. As we have seen, the United Provinces sál longicorn is often accompanied by the *Sphaerotrypes* bark-borer of that locality.

The evidences of the *Hoplocerambyx* attack (so often disguised by the luxuriant growth of creepers on the trees in Assam and Eastern Bengal) are very visible in the Central Provinces:—

(1) The trees pour out masses of resin at the points where the grubs are working below the bark. These masses coagulate on the tree and are very visible in a bad attack.

(2) In old attacks the bark of the tree may be seen to be lifted and broken or hanging in pieces, thus exposing the galleries of the larvae, filled with condensed masses of excreta and wood-dust, in the sapwood.

(3) Woodpeckers tunnel into the tree to get at the grubs beneath. (This may be seen in Assam as well as in the Central Provinces.) A large number of small holes on the trees show where woodpeckers have bored in to get at the grubs. These holes are not large in the Central Provinces, and it is evident that the birds only attempt to reach the young grubs whilst they are still in the outer sapwood. The holes made are not big enough to haul out large grubs by, and quite unlike the enormous funnel-shaped orifices made by the birds in Assam (see fig. 222).

Protective and Remedial Measures.

It is extremely important that every possible means of combating this insect in the forest should be made use of, since the damage it is capable of committing both from a sylvicultural and economic point of view is very great.

(1) The most effective form of protection would of course be to undertake fellings only at periods when it is known the beetle is not on the wing, and therefore not egg-laying. It has been shown in the case of trees felled in February that no fresh eggs were laid on the bark by the beetles

flighting in May. This would seem to prove that the beetles will not lay on the bark of trees two months or more old. Now, the great increase or the presence of this insect in constant large numbers in areas where fellings are taking place is not so much due to the insects arising from eggs laid in the bark of the convertible bole, since the bole may have been barked and cut up before the larvae have reached even half size, as to those bred in the large crowns of the trees which are left in the forest unbarked and unused owing to there being no demand for such wood. This is one of the great sources of danger, since it is impossible at present to hope either to make use of this material or to get rid of it in any cheap manner. This source of danger can be minimized or entirely obviated by felling the trees, provided such a practice is possible, at times when the beetles are not present in the forest, and at least two months before they are likely to appear.

(2) Bark every tree within a week of felling, and when possible remove the bark from the larger branches in the crown.

(3) In the case of an insect of this kind there is but one way at present of combating it successfully in India, and that is the drastic one of cutting out seriously infested trees. These should be barked, and if it is seen that they contain a large number of grubs the trees should be logged and burnt. It will not be necessary to reduce the whole to ashes, if there is no demand for charcoal in the locality. If the sapwood is properly burnt sufficient heat and smoke will have penetrated into the interior of the heart-wood down the larval tunnels to have killed off all pupating grubs, pupae, or nearly mature beetles. This operation may be carried out at any time of the year except when the beetles are issuing, i.e. between the beginning of May and end of July.

It must be remembered that infested trees in a block of forest mean the spreading of the pest to neighbouring healthy ones, and that consequently the sacrifice of the infested patch will save the rest of the block. In carrying out the operation the greatest care should be exercised in seeing that the logs are properly burnt and that any large branches showing signs of the presence of the beetle are treated in the same way.

Range Officers should be instructed to report the fact of there being dying trees or dying patches of trees in their charge, and with the report they should be able to state whether the damage is due to the presence of this pest. If the trees are being killed it may, if the matter is taken in hand sufficiently early, be possible to save a portion of the timber from being ruined in the case of those not very seriously infested.

(4) The numbers of the beetles present in a forest may be easily ascertained by felling trap trees at the periods when the beetles are on the wing. These trees should be visited every morning for at least a week after felling, and all the beetles found on the bark and in the adjacent low jungle growth

should be collected. The bark should be removed from these trees at the end of the week, unless it is wished to study the life history of the insects further.

(5) In the case of severe infestations of the beetles in the forest, a number of trap trees should be felled for the purpose of attracting the beetles to them to lay eggs. By collecting and killing all the beetles present, and barking the trees at the end of the week, a severe check will have been put on the increase of this pest. The bark should be stacked and burnt unless it can be exposed to a hot sun for a few days, which will serve the purpose equally well.

Ichneumon sp.—The Ichneumon grub feeds parasitically on the *Hoplocerambyx* one, killing it.

Parasitic and Predaceous Foes.

Pupal Covering or Cocoon.—Smoky grey, papery in texture, elliptical lozenge shape, with vertical sides. Length, 27 mm.

Fly.—Shining, elongate, slender. Head yellow; thorax red; basal part of wings, which are membranous, yellow, apical half black; tibiae and tarsi black. Length, about 24 mm. Described from a poor specimen taken dead from a cocoon. The figure shows the pupal case of this insect and the fly.

FIG. 220. *Ichneumon* sp., parasitic on *Hoplocerambyx spinicornis.* Cocoon and fly. Assam.

Life History.—The egg or eggs of this fly are laid by the female in the tunnel near or on the *Hoplocerambyx* larva. On hatching out the young parasitic grub feeds upon the tissues of the beetle-larva either as an internal or external parasite. The former is not killed under the attack until it has reached its full size and formed its pupal chamber in the interior of the tree. This is evidenced by the fact that the beetle-larva has strength enough to enclose its pupal chamber with the calcareous covering before it finally dies from exhaustion. The Ichneumon grub then pupates in safety in the closed pupal chamber, first spinning a smoky-grey papery elliptical cocoon with vertical side walls, resembling an elliptical lozenge, as shown in the figure. How the fly gets out of the pupal chamber through the calcareous covering is not apparent. The only specimen taken was found dead in the cocoon. It is quite possible that the only chance of the fly getting out of the tree lies in its grub killing the beetle-larva before it closes in the pupal chamber with the calcareous covering. That more than one Ichneumon grub feeds upon the beetle one is evidenced by the fact that two of the papery cocoons were found side by side in the latter's pupal chamber. Although this fly does not prevent the damage being done to the trees, since it would appear that the larva forms, or nearly forms, its pupal chamber in the tree and therefore is not killed until it has done all the damage it can, the insect is of undoubted value in the forest, since it keeps down the number of future beetles. It is therefore of considerable interest that its life history

should be fully worked out. Where the eggs are laid, the number laid in one beetle-tunnel or on the larva, how the grub feeds upon the beetle-larva, whether the latter is usually killed before making its calcareous covering to the pupal chamber, how the fly leaves the tree, and the number of generations of the insect in the year, are some of the points requiring investigation.

Bothrideres? sp. (p. 112)—The grub of this beetle apparently feeds upon the *Hoplocerambyx* grub as an external or internal parasite, eventually killing the latter before it pupates.

Cocoon.—The cocoon consists of a yellowish-coloured parchment material which appears to be made of very closely spun fine fibres of a ligneous nature. It is elliptical in shape and 4.2 mm. in length. The cover was spun with a few fine silk threads to the shrivelled skin of the cerambyx larva.

Beetle.—Elongate, narrow, reddish brown in colour. Thorax square, anterior margin concave, disk convex, punctate. Elytra moderately convex, punctate-striate. Length, 5.8 mm. Fig. 221 shows cocoon, beetle, and a shrivelled skin of a *Hoplocerambyx* larva.

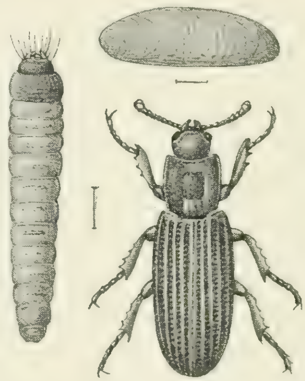


FIG. 221.

Bothrideres? sp. Cocoon and beetle. Shrivelled skin of *Hoplocerambyx* larva (on the left) from which the beetle was bred. Assam.

Life History.—In a larval gallery of *H. spinicornis*, opened out whilst splitting up a green sál-tree felled in the Kachugaon forests on 16 May 1906, a blackish shrivelled skin of the grub of this beetle was found. The larva had been engaged in eating out the gallery in the heart-wood which finally terminates in the pupal chamber, and had died from exhaustion whilst performing this operation. Beside the shrivelled skin was the small elliptical cocoon described above. Both skin and cocoon were transferred to a tube and kept under observation. An examination of the tube on 19 May disclosed the fact that one-half of the cocoon had been eaten down longitudinally, a reddish-coloured beetle being observable inside. No material change occurred on the 20th. On the 21st an inspection showed that the beetle had eaten almost all the cocoon away and had emerged from it.

I explain the life history as follows: The colydiid larva feeds upon the longicorn grub either externally or internally, most probably the former, parasitically, the grub eventually dying of exhaustion. The parasite then spins a cocoon, which it attaches to the drying skin of the dead grub, and pupates.

Whilst this insect is a most useful one, further observations are required to ascertain its abundance in the forest before its value as an aid towards keeping down the sál-borer pest can be decided. The points in the life history already given under the Ichneumon parasite require investigation in the case of this insect also.

Attacks of Woodpeckers on Hoplocerambyx.—The large green woodpecker, which is fairly plentiful in the Goalpara forests, drills holes in the green standing trees to get out the larvae engaged in cutting out their pupal chambers or those already in the latter either in the larval or pupal stage. Whilst engaged in this operation the bird destroys the timber of the tree by making holes of a considerable size, which holes may subsequently become enclosed by a growth of later superimposed layers of wood. These, when the tree is not seriously infested, will result in greater damage to the timber than the mere presence of a few pupal chambers in the wood would have caused. At the same time the bird probably does a great deal of good by boring into and extracting grubs, etc., from badly infested trees, the wood of which had been already irretrievably ruined by the insect. Fig. 222, from a photograph by Mr. R. N. Mukerjee, shows the trunk of a sál-tree badly riddled by woodpeckers in searching for *Hoplocerambyx* larvae in the sapwood and heart-wood.

FIG. 222.—Holes made by the large green woodpecker in young sál-trees to get at the larvae of *Hoplocerambyx spinicornis* in the bast and sapwood. Goalpara, Assam.

Pachydissus.

Pachydissus sp.

Habitat. — Siwaliks, United Provinces.

Tree Attacked.—Jhingham (*Odina wodier*). Jumna Bridge, Kalsi (M. Kauli Ghosh).

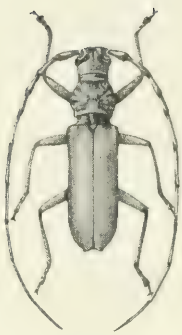


Fig. 223.
Pachydissus sp.
Siwaliks.

Beetle.—Elongate, narrow. Black, covered with a golden pubescence, giving a silky reflexion to the upper surface. Front of head coarsely rugose and channelled between the antennae; vertex transversely and finely striate behind the eyes; first joint of antennae swollen; second very short; third as long as first and second together; fifth longer than fourth; sixth equal to fifth and fourth together. Prothorax widest medianly, narrow in front, the disk coarsely and transversely corrugate and channelled. Elytra elongate, sides straight, constricted abruptly near apex, latter truncate and spined; disk finely and irregularly punctate. Under-surface densely covered with the yellow pubescence, punctate. Length, 28 mm.

Description.

A specimen of this insect was cut out of its pupal chamber in the sapwood of a half-dead *Odina wodier* tree by Student M. Kauli Ghosh of the Imperial Forest School at Dehra, on 9 January 1902. The beetle was dead, but a living larva was obtained from another gallery. This note and the insects were made over to me by the student. No further specimens would seem to have been taken since then.

Dialeges.

Only one species of forest importance is known.

Dialeges pauper, Pascoe.

References.—Pascoe, *Trans. Ent. Soc.* (2), iv, p. 47, pl. 16, fig. 7 (1856); id. ibid. (3), iii, p. 521; *Dialeges tenuicornis*, Pascoe, *Trans. Ent. Soc.* (3), iii, p. 522 (1869), ♀; Gahan, *F.B.I.* Ceramb. no. 144, p. 142 (1906); Stebbing, Some Assam Sál Ins. Pests, *For. Bull.* no. 11, p. 18 (1907).

Habitat.— Sál Forests, Goalpara, Assam. Gahan in *Fauna* gives Allahabad, Darjeeling, Assam, Patkai Mountains (Doherty), Perak, Penang, Singapore, Borneo.

Tree Attacked.—Sál (*Shorea robusta*). Goalpara, Assam.

Beetle. — Elongate, slender. In colour varies from reddish brown to dark brown; rather densely covered with a greyish-brown silky pubescence, save on prothorax, which has a few longitudinal depressions bare of pubescence; the pubescence on

Description.

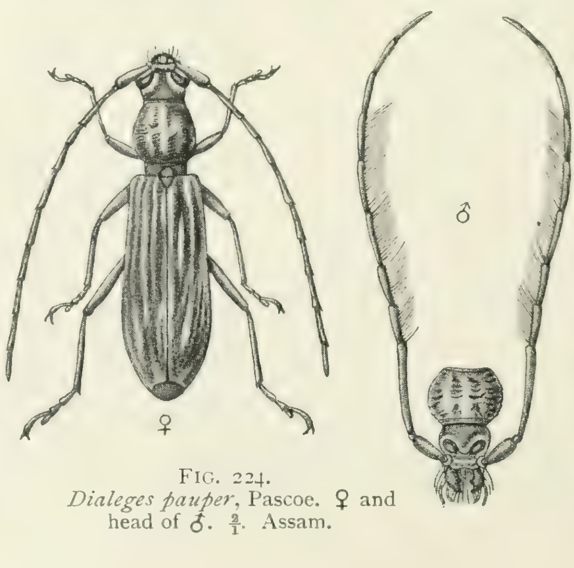


Fig. 224.
Dialeges pauper, Pascoe. ♀ and head of ♂. $\frac{2}{1}$. Assam.

the elytra somewhat denser and arranged so as to give short, ill-defined longitudinal bands or patches of lighter or darker shades (the latter often looking black), according to the play of light upon them, the reflexions in certain lights being silvery; two bands, darker in colour than the rest, are situated near together a little behind the middle of each elytron. Head elongated posteriorly, the eyes being completely divided. Antennæ one-third or more longer than the body in ♂, about one-sixth longer than the body in ♀; second joint as broad as long; third nearly or quite as long as fourth and fifth together; fourth to eighth and apex of third fringed beneath with hairs in ♂. Prothorax constricted before and behind, longer than its width across middle in ♂, shorter in ♀; transversely but irregularly wrinkled above, and marked with some longitudinal or oblique depressions. Elytra truncate at the apex, each armed with a short spine at the suture and tooth at the outer angle. Femora stout in the ♂, hind tarsus narrow, first joint much longer than the next two united. (*Descr. after Gahan.*) Length, 16 mm. to 31 mm.; breadth, 3½ mm. to 8 mm.

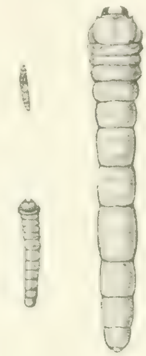


FIG. 225. Young and mature larvae of *Dialeges pauper*, Pascoe.

Larva.—The grubs are of the ordinary longicorn type and are shown in fig. 225. White with blackish-brown heads and mandibles, and orange streaks on the thoracic segments The youngest found was ¼ in. Fully mature grub 1 in. to 2 in. in length.

Life History.

A generation of the beetles appears on the wing about the middle of April. The eggs are evidently laid in the interstices of the bark of the tree. They probably soon hatch out, and the young grubs feed at first in the bast. As they grow in size they feed in the bast and sapwood, mining out irregular galleries which are shallow and packed closely with woody excrementitious particles. The larval galleries are roughly eight to twelve inches in length or at times longer. When the larva is full-grown it bores into the sapwood at an angle to its previous direction, going in three to four inches, and then gnaws out a pupal chamber in the longitudinal axis of the tree. This pupal chamber is always made in the sapwood. Near the upper end it is covered over with a cap of some calcareous material white in colour and similar to that made by *Hoplocerambyx spinicornis*, but much smaller and without the keel-shaped edge. The gallery in the sapwood is square in section and a quarter of an inch across. The pupal chamber is 1½ in. long.

The insect was found in both larval and beetle form on 29 April. The larvae were either quite young or mature. I do not know the length of time spent in the larval and pupal stages, but it is probable that the mature larvae and the beetles found were those of the first generation of the year, and that the young larvae were those of a second generation. As only a few beetles were found active it appeared probable that the majority of the insects had already left the tree and laid their eggs. The insect may pass through two life-cycles in the year.

Damage Committed in the Forest.

This insect was evidently plentiful in the Anguri Block of the Hultugaon Forest (Goalpara) in 1906. Dead trees showed the sapwood often tunnelled out from top to bottom with the larval galleries, and dead beetles were cut out from the pupal chambers in such trees. Stag-headed or dead tops of living trees also

disclosed the evidences of past attacks. Lower down in the green still-living portion of the stem grubs were found at work and also beetles just ready to emerge. The insect would appear to be a pest of considerable importance, since the grub feeds entirely in the bast layer and sapwood, destroying the former when numerous. A dead tree examined showed the whole of the bole from top to bottom covered with a mass of old larval galleries, indicating that the major portion of the cambium layer of the tree had been destroyed by the insects. It is not improbable that the trees are reduced to the sickly condition best adapted for the attacks of this insect by being partially strangled by the creepers which infest these forests. The insect is also favoured by being able to lay in all newly felled trees and unbarked tops left in the forest.

The cause of death of the beetles found in the pupal chambers has not been discovered, but the insect is apparently parasitized by the Ichneumon fly described below. Methods of combating attacks of this pest are identical with those described under *H. spinicornis*.

Bracon sp.—The Bracon grub feeds upon the *Dialeges* larva as an external or internal parasite, finally killing it.

Cocoon.—Smoky grey, flat, elliptical in shape, consisting of a very thin shining papery material.

Parasitic Insect.

Fly.—Elongate, slender, shining orange-red. Head dark red with black rather short antennaeand a long curved ovipositor longer than the total lengthof the insect; the wings are membranous, slightly longer than the insect; anal tips with smoky bands and upper wings with three black spots, two on the exterior edge of the upper half and one on the inner edge in a line with the lower spot. Length, 18.2 mm.

FIG. 226.
Bracon sp. Cocoon and Fly. Parasiticon *Dialeges pauper*. Assam.

Life History.—This Bracon would appear to lay its eggs in the neighbourhood of those of the longicorn or on the grub itself after it has hatched out. The parasite feeds upon the latter, but does not apparently eventually kill it until it has eaten out the pupal chamber and closed it over with the calcareous covering. The parasite then leaves its host, the latter shrivelling up, and spins the papery elliptical cocoon and pupates inside it. I do not yet know at what period or periods the fly issues, since I have only taken dead flies *in situ* in the pupal chamber. They were taken from pupal chambers in the tree in which the dead beetles were discovered.

Further investigation into the life history of this insect is required. How many life-cycles the Ichneumon passes through during the year, how its grub feeds upon the longicorn one, how the fly gets out of the closed pupal chamber, and its abundance in the forest, are some of the points which present themselves for decision.

XOANODERA.

Xoanodera regularis, Gahan.

REFERENCES.—Gahan, *A.M.N.H.* (6) v, p. 52 (1890); ? *Xoanodera pascoei, Brongn. Nouv. Archiv. du Mus.* (3) iii, p. 239 (1891); Gahan, *F.B.I.* Ceramb. i, no. 155, p. 150 (1906).

Habitat.—Darrang, Assam. Gahan gives N. India ?, Burma: Ruby Mines, Karenee (Doherty), Tenasserim, Thagata (Fea), Tavoy (Doherty).

Tree Attacked.—India-rubber (*Ficus elastica*). Charduar Rubber Plantation, Darrang, Assam.

FIG. 227.
Xoanodera regularis, Gahan. × 7/4. Assam. (*F. B. I.*)

Beetle.—Dark brown or almost black in colour; the elytra covered for the greater par with a dense yellowish-white pubescence, each with a

Description.

basal spot close to the scutellum, and a lateral plaga that extends from the shoulder to a little past the middle, deeply and very strongly punctured and bare of pubescence, the narrow border between the submarginal carina and the outer margin sparsely pubescent. Disk of prothorax with four or more straight, sharp, longitudinal ridges, and a rather dense covering of yellowish-white pubescence on the sides. Breast and abdomen rather densely, the legs less densely covered with a greyish-white pubescence. Length, 17 mm. to 21 mm.; breadth, 5 mm. to 6 mm.

Life History.

I took a specimen of this beetle in the Charduar Rubber Plantation in the Darrang Division in Assam on 6 April 1906. Its flight time in this part of India may be taken, therefore, as the first weeks in April. The insect had just issued from a hole in the bark of a rubber-tree of pole growth, the larval gallery being traceable inside the tree between the bast and sapwood. I have no further notes on the life history of the insect. The beetle is remarkable owing to the close approximation of its colouring to that of the bark of the rubber-tree. The light markings on the elytra blend in an astonishing manner with the bark, so much so that at a very short distance from the tree the beetle is indistinguishable from the bark surface.

GELONÆTHA.

Only one Indian species of the genus is known.

Gelonætha hirta, Fairm.

REFERENCES.—Fairm. (*Stromatium*), *Rev. et Mag. de Zool.* 1850, p. 60; *Gelonætha curtipes*, Thoms. *Rev. et Mag. de Zool.* 1878, p. 13; *Astrimus obscurus*, Sharp, *Trans. Ent. Soc.* 1878, p. 204; Gahan, *F.B.I.* Ceramb. i, no. 161, p. 155 (1906).

Habitat.—Salween River, Tenasserim; Southern Shan States. Gahan gives Calcutta; Coromandel Coast; Nilgiri Hills; Siam; Philippine Islands; Sandwich Islands; Tahiti.

Tree Attacked.—Teak (*Tectona grandis*). Wutgyi, Salween River (*mihi*); Southern Shan States (Watson).

Beetle.—Description. Reddish brown to dark brown in colour; scantily clothed with greyish depressed pubescence interspersed with moderately long sub-erect tawny setae. Head densely punctate, marked above with a feeble median groove which extends anteriorly between the antennal supports. Prothorax densely rugulose-punctate, somewhat sparsely asperate at sides; the disk with a postero-median and two nearly obsolete anterior callosities. Elytra densely punctate, the punctures somewhat unequal in size, rather strong on the anterior half and gradually smaller towards the apex; each elytron with one or two feebly raised longitudinal lines. Abdomen very sparsely punctate. Length, 9 mm. to 16 mm.; breadth, $2\frac{1}{4}$ mm. to $4\frac{1}{2}$ mm.

FIG. 228. *Gelonætha hirta*, Fairm. $\times \frac{2}{1}$. Tenasserim. (*F. B. I.*)

Life History. I took a specimen of this insect from its pupating-chamber in the sapwood of a recently felled green teak-tree on 7 March 1905. The larvae feed in the bast and sapwood, eating out rather narrow winding galleries blocked with wood-dust. When full-fed they bore about half an inch into the sapwood, and then eat out there an elongate narrow chamber parallel to the long axis of the tree. The beetles evidently fly early in March. It is possible that there are two generations of the insect in the year.

The *Gelonætha* accompanies *Xylotrechus smei* (p. 347) in its attacks on the teak-tree in Tenasserim.

Mr. W. H. A. Watson found the insect in teak in the Southern Shan States in 1910. He wrote: "I notice that, after girdling, teak-trees in this division are extensively attacked by a beetle. The main period of attack appears to be the first eighteen months after girdling . . ." This is a most interesting observation. Although the insect does no damage of any importance to old trees, since it only goes into the outer sapwood to pupate, its increase in any large numbers, owing to the provision of the necessary breeding places in the newly girdled trees, may have the most serious effects on young teak areas in the future. The larva is a bast feeder, and quite capable, when in numbers, of killing pole growth.

TRINOPHYLLUM.

Only one Indian species is known. It is probably one of the most serious pests of the deodar.

Trinophyllum cribratum, Bates.

(*The Deodar Longicorn Bast-eater.*)

REFERENCES.—Bates, *P.Z.S.* 1878, p. 720; id. *Scientific Results Second Yarkand Mission*, Col. p. 22, pl. 1, fig. 19 (1890); Gahan, *F.B.I.* Ceramb. p. 156, no. 162.

Habitat.—The beetle is probably to be found throughout the entire area occupied by the deodar in the Western Himalaya.

Gahan in the *Fauna* gives Murree; Kashmir; Assam; Sylhet—a somewhat curious distribution. This is the only species of the genus given in the *Fauna*.

Tree Attacked.—Deodar (*Cedrus deodara*). Deodar tracts, North-West Himalaya.

Beetle.—Chestnut brown in colour, more or less nitid, sparsely furnished above with short semi-erect fulvous brown hairs. Head and basal joints of antennae finely rugulose-punctate.

Description.

Prothorax closely and rather strongly punctured; marked with a feeble sinuate groove or depression near the apex and another near the base; the disk slightly depressed along the middle with a very narrow impunctate space behind. Elytra closely and strongly punctured, less strongly near the apex. Body beneath reddish brown, sparsely pubescent, less closely and rather finely punctured; prosternum transversely depressed a little behind the front margin; abdomen narrowed posteriorly, first segment longest, second to fourth successively shorter. Legs reddish brown, minutely and sparsely punctate. (*Descr. after Gahan.*) Length, 11 mm. to 13 mm.; breadth, 3½ mm. to 4 mm.

Young Larva.—The young larva is a tiny white grub of about half an inch in length with a large prothorax, brownish weak mandibles, and narrow body segments (fig. 231, *a*).

Full-grown Larva.—White to whitish-yellow in colour, with a brown head and powerful black mandibles. The prothorax is greatly enlarged and is hard. The succeeding segments are rather corrugated, taper posteriorly. Segments 2 to 10 have each a stigma placed laterally near the ventral surface. Length, 25 mm. (fig. 231, *b*, *b1*).

Pupa. — The pupa is elongate, white to whitish - yellow in colour, and has the appearance to some extent of the future beetle. The antennae are pressed against the sides and the legs and wings against the chest. Fig. 231, *c1*, *c* shows the pupa natural size and enlarged.

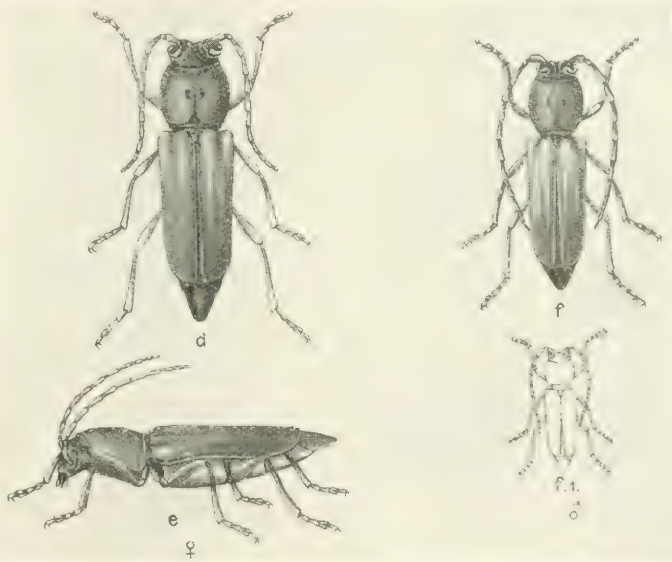


FIG. 229.—*Trinophyllum cribratum*, Bates. *d*, *e*, Female, enlarged; *f*, *f1*, Male, enlarged and natural size. North-West Himalaya.

Life History.

It has been known for some years that deodar-trees, and especially felled or blown-down green deodar-trees, soon become infested with longicorn larvae.

In 1901 I found trees of this species infested with both buprestid and longicorn grubs in Bashahr.* The following year at Pajidhar in Jaunsar in a recently felled large green deodar I took on 24–28 June young buprestid and longicorn larvae, some perhaps a fortnight old, others probably but a couple of days old.

* *Depart. Notes*, i, p. 49.

These had made little shallow galleries, as shown in fig. 230, on the inner surface of the bark all over the main stem.

At Konain in Jaunsar again I took numerous partially grown grubs in November 1906 in the tops of green trees felled and converted during the year; I had never found the beetle in the tree, however.

FIG. 230.
Galleries of young larvae of *Trinophyllum cribratum* in bast of deodar.

The life history of this longicorn beetle was worked out during the years 1908–9 in the Simla Catchment Area Deodar Forest with the aid of Mr. V. Munro, the Divisional Officer; Pundit Gokal Das, Extra Assistant Conservator of Forests; and the Range Officer. This area was visited by a bark-beetle attack (*Scolytus* and *Polygraphus*) which began in October 1907. To combat this attack trap trees were felled over the area about 22 May 1908 and a few days subsequently.

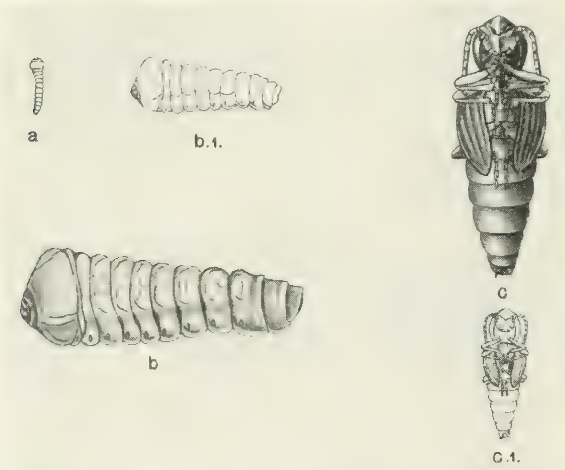


FIG. 231.—*Trinophyllum cribratum*, Bates. *a*, Young larva; *b*, *b*1, full-grown, enlarged and natural size; *c*, *c*1, pupa enlarged and natural size.

On 9 and 10 August 1908 I inspected a number of these trap trees and found them to contain young longicorn grubs. It was therefore obvious that the beetles must have appeared on the wing in the forest some time between the commencement of June and the end of July, and oviposited in the felled green trees.

The trees containing the grubs were kept under surveillance by the Divisional Officer and Range Officer during the rest of the year and up to June 1909, in which latter month pupae and beetles were obtained from them in considerable numbers. We are thus now in possession of the complete life-cycle of the insect.

I may mention here that the longicorn appears to be often accompanied by the buprestid *Sphenoptera aterrima* already described (*vide* p. 204).

The beetle issues from the trees and appears on the wing in the forest in June, pairs, and the female then searches out newly felled trees or sickly standing trees in the forest, and oviposits on them. The eggs are laid singly in crevices in the bark, on the lower part of felled trees, and on the northern or shady sides of standing trees, the number laid by each female being unknown.

W. F. Perree, photo.

Larval galleries containing living larvae (in some cases) of *Trinophyllum cribratum*, Bates, on the inner surface of deodar (*Cedrus deodara*) bark. Simla Catchment Area Forests, North-West Himalaya.

On hatching out the young larvae at once bore down into the cambium layer and feed in this for a time. As they grow bigger the gallery grooves both bast and sapwood. These galleries curve about in an irregular manner and increase in width and depth with the growth in size of the grub. Pl. xxiv shows a photograph of the inner surface of a piece of bark stripped from an infested tree in September. The photograph was very kindly taken for me in the forest by Mr. W. F. Perrée, at the time Assistant Inspector-General of Forests.

It depicts very well the stage in the development of the larvae some three months after oviposition, and also shows the amount of cambium they are capable of destroying in this period when numerous in a tree. It will be noticed that the larval galleries are blocked for their whole length, with the exception of the space occupied by the grub itself, with wood refuse and excreta of the grub.

The larvae continue feeding in the bast and sapwood until the first snap of cold of the winter, when they cease feeding and hibernate at the end of their galleries. A few may have bored the pupating-chamber in the wood, but the majority are still far from full-grown.

Some time in April the larvae recommence feeding, and lengthen their galleries to some extent. In May they commence tunnelling down into the sapwood, boring out a short gallery of a half to three-quarters of an inch in length and of squarish section. This tunnel may go in at an angle or be straight. It is always kept quite free of wood-dust and excreta. When this depth in the wood has been reached the larva turns and bores out an elliptical elongate chamber parallel to the long axis of the tree and of wider diameter than the entrance-tunnel to it. When this is complete it turns round and changes into a pupa.

The period passed as a pupa and immature beetle is about a month to six weeks, and the beetle is then ready to leave the tree. It crawls up the entrance-tunnel in the sapwood, gnaws through the outer bark which covers it, and escapes from the tree to mate and, if a female, lay eggs in fresh trees.

From the above it is apparent that the deodar longicorn beetle has only one life-cycle or generation in the year, and passes through the winter as a grub, perhaps the easiest stage and period to attack it in.

Damage Committed in the Forest.

This longicorn must be looked upon as one of the serious pests of the deodar. Like its companions *Scolytus major*, *Polygraphus major*, and the buprestid *Sphenoptera*, it is ever ready to take advantage of any sickliness or injury to a tree or any reduction in vitality resulting from a fire having passed over the area. It is probable that it only attacks green trees when it is in large numbers, and when the supply of newly felled and sickly trees is small. It will not, however, oviposit in dry trees, since it requires for its larvae that the cambium should be in a state of considerable freshness.

The danger to be feared from this and the other pests is when a sudden storm leads to a large number of wind-falls in the forest during the egg-

laying season of the insects, or when heavy snow-breaks result in a large number of partially broken-down and sickly trees being present in the forest. To such places this longicorn will invariably repair to oviposit.

Protective and Remedial Measures.

These are the same as already detailed for the buprestid pest (*Sphenoptera aterrima*). At present my observations have not resulted in discovering any parasitic foes of this longicorn. I am not aware whether the Ichneumon fly, *Ephialtes*, which parasitizes the buprestid grubs (*vide* p. 207) also infests the longicorn grubs.

Ceresium.

The genus contains several Indian representatives. One is well known as a serious pest to the casuarina plantations in Madras.

Ceresium simplex, Gyll.

References.—Gyll. (*Stenochorus*), *Schönh. Syn. Ins.* app. ii, p. 178 (1817); *Arhopalus ambiguus*, Newman, *Entomologist*, i, p. 246 (1842); Stebbing, *Depart. Notes*, vol. i, p. 374 (*Stromatium* sp. prox. *barbatum*) (1906); Gahan, *F.B.I.* Ceramb. i, no. 175, p. 162 (1906).

Habitat.—North Arcot, Cocanada. Gahan gives N. India; Burma; Tenasserim; Ceylon; Nicobar Islands; Philippine Islands; Sumatra and Java to New Guinea; Mauritius and Madagascar. Recorded also from Mexico.

Tree Attacked.—Casuarina (*Casuarina equisetifolia*). North Arcot, Cocanada.

Description.

Beetle.—Brownish testaceous; antennae and legs yellowish. Head rather densely covered above with pale yellowish pubescence. Antennae a little longer than the body in ♂, not quite so long as it in ♀; third joint not longer than first, distinctly longer than fourth; fifth and sixth sub-equal, each longer than third. Prothorax almost as broad as long, slightly rounded at sides, these covered with greyish pubescence; disk faintly covered with greyish pubescence in the middle, marked with two spots or a longitudinal band of dense tawny-yellow pubescence at each side; a narrow median and some small laterally placed callosities, smooth and glabrous; the intervening spaces sparsely and irregularly punctured. Elytra closely and strongly punctured from the base to the middle, the punctures nearest the base somewhat granulate, the punctures becoming feebler as they approach apex. Femora fusiform-clavate, thickened gradually almost from the base. Length, 11 mm. to 16 mm.; breadth, 3 mm. to $4\frac{1}{4}$ mm. (*Descr. after Gahan.*)

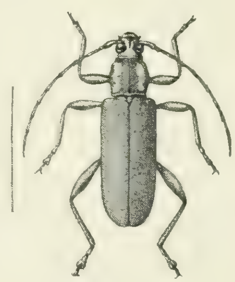


Fig. 232. *Ceresium simplex*, Gyll. Madras.

Larva.—Elongate, but slightly corrugated; white; about 1 in. in length.

Life History.

The first notice of this insect occurring as a pest in Madras was furnished by Mr. C. D. Thornton, I.F.S. Larvae were found in the cambium layer of casuarina-trees, occurring apparently more especially in old trees. The grubs eat out long galleries which groove both bast and sapwood, and when in numbers they completely ring the tree, thus causing its death. Larvae were first taken in December, about half-grown, the beetles issuing from the trees in June. The grubs probably pupate about April, the following two months being spent in the pupa and resting-beetle stages. The larval life, during which

the damage is done to the tree, thus lasts from some eight to nine months, unless there are two generations in the year, which appears improbable.

Damage Committed in the Forest.

This is the longicorn beetle whose white grubs have been reported to infest the casuarina in company with those of the moth *Arbela tetraonis*, which has proved such a scourge to the tree. In December 1900 Mr. C. D. Thornton reported that the grubs "had nearly ruined the casuarina-trees in the Aminundi Plantation. . . . The grub is found in the cambium layer, under the bark of old trees, on which it feeds." Since then reports have come in from several quarters that longicorn insects, which have proved to be this pest, have committed serious damage in the plantations.

Protection and Remedies.

In plantations the only method of getting rid of a bad attack is to cut out and burn all badly infested trees. When this has been done a few green trees should be felled just before the appearance on the wing of the beetles. The latter will oviposit in these trees in preference to green standing ones, and about January the trees can be cut up and burnt. The trap trees should be felled some three weeks before the beetles will appear.

Purpuriscenus.

The species known to attack trees were reported from Baluchistan and the North-West Himalaya.

Purpuriscenus haussknechti, Witte.

References.—Witte, *Berl. ent. Zeit.* xv, p. 207 (1871); *Purpuriscenus haussknechti*, var. *aleppensis*, Witte l.c. p. 208 (♂); Gahan, *F.B.I.* Ceramb. i, no. 202, p. 186 (1906).

Habitat.—Fort Sandeman, Baluchistan. Gahan in the *Fauna* gives Kashmir; Punjab; Turkestan.

Tree Attacked.—*Populus ciliata* (Baluchistan).

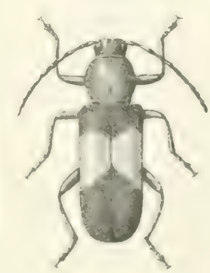


Fig. 233.
Purpuriscenus haussknechti, Witte.
Baluchistan.

Description.

Beetle.—♂ Black; prothorax with a red spot of variable size on the middle of the disk, sometimes also with a red spot on each side united by a red band with the discal spot; elytra with a broad red band across the middle, widened from the suture towards the outer margin and extended anteriorly to a greater or less extent as a marginal band. Head closely and somewhat roughly punctured; the antennal supports raised and acute on the inner side. Antennae longer than the body, with the last joint longer than the penultimate and tapered towards the end. Prothorax closely, strongly, and roughly punctate above; a small median tubercle just behind centre of disk and a smaller one behind this on each side. Elytra very closely punctured, the punctures gradually smaller as they recede from the base. (*Descr. after Gahan.*) Length, 12 mm. to 23 mm.; breadth, 4 mm. to 7 mm.

♀ Prothorax red above with a narrow edging of black on anterior and posterior margins. Antennae shorter than body, elytra with the red band very broad, occupying two-thirds of the basal portion save for a narrow black edging on basal margin; apical third black. Slightly smaller than some of the males.

Life History.

In October 1907 the Extra Assistant Conservator of Forests in Baluchistan forwarded me a specimen of the female beetle of this insect. Towards the end of April 1909 Captain E. H. James, Officiating Political Agent at Fort Sandeman in Zhob, sent me a female specimen of this beetle, and in December of the same year a male. Captain James's specimens were caught on the wing in the station garden, but the specimen sent by the Extra Assistant Conservator was found infesting *Populus ciliata.* It is difficult to account for the males being taken in the late autumn and commencement of winter, whilst the female was taken in the spring. It may be, however, that the females hibernate and oviposit in the spring.

The Extra Assistant Conservator took some grubs in the trees.

Purpuriscenus montanus, White.

REFERENCES.—White, *Cat. Col. B.M. Longic.* p. 138 (1853); id. *P.Z.S.* 1850, pl. 8; Gahan, *F.B.I.* Ceramb. vol. i, no. 203, p. 186 (1906).

Habitat.—Tehri Garhwal, North-West Himalaya. Gahan gives West Kashmir; Campbellpore; Himalaya; Tibet.

Tree Attacked.—Blue Pine (*Pinus excelsa*). Kulni, Tehri Garhwal (V. Subramarian Iyer).

Description.

Beetle.—Relatively long and narrow for this genus; variable in colour, sometimes entirely black, most commonly black with the outer borders of the elytra to a greater or less extent red; in some specimens the elytra are red with a broad black band along the middle of each, and the prothorax is marked with a red spot or band on each side in front of the lateral spine. Head, prothorax, and elytra densely rugose-punctate, the prothorax sometimes with a smooth narrow callosity in the middle. Antennae twice or nearly twice as long as the body in the ♂, shorter than the body in the ♀. Prothorax with a small acute tubercle on each side. Elytra long, parallel-sided, rounded at apex. Femora sub-linear, very slightly thickened in middle; first joint of hind tarsus shorter than the next two joints united. Length, 11 mm. to 16 mm.; breadth, 3 mm. to $4\frac{1}{2}$ mm.

Whilst a student at the Imperial Forest School at Dehra a specimen of this insect was taken by Mr. V. Subramarian Iyer, of the Madras Provincial Forest Service, from the sapwood of the blue pine at Kulni in Tehri Garhwal on 18 May 1901. This is the only record I have of the insect being taken from the tree.

CHLORIDOLUM.

Chloridolum alcmene, Thoms.

REFERENCES.—Thoms., *Syst. Ceramb.* p. 568 (1865); Gahan, *F.B.I.* Ceramb. i, no. 218, p. 199 (1906); *Agric. Jour. Ind.* i, p. 129.

Habitat.—Coorg, Nilgiris. Gahan gives Assam; Andaman Islands; Burma; Karenee (Fea); Ruby Mines (Doherty).

Tree Attacked.—Orange (*Citrus aurantium*). Coorg.

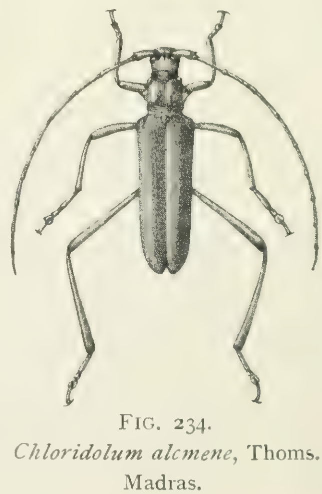


FIG. 234.
Chloridolum alcmene, Thoms.
Madras.

Description.

Beetle.—Metallic green; legs and antennae dark blue, passing into bluish-black or black towards extremities; prothorax with a closely rugulose punctured area, more or less covered with black pubescence on each side of middle of disk; the elytra with a faint covering of a short pubescence in parts. Head rugulose-punctate posteriorly, transversely striated at sides. Prothorax with a sharp tubercle at the middle of each side, and a narrow obtuse transverse tubercle near the front margin; the upper surface transversely striated in front and at the base, and also in curving lines at sides of disk; longitudinally rugulose along the middle of the disk between the pubescent areas. Length, 20 mm. to 36 mm.; breadth, $4\frac{1}{2}$ mm. to 8 mm.

The larvae of this insect tunnel in the bast and sapwood of orange-trees.

XYLOTRECHUS.

The genus is represented by a number of species in India, several of which would appear to be of considerable importance as pests in the forests.

Xylotrechus smei, Lap. et Gory.

REFERENCES.—Lap. et Gory (*Clytus*), *Hist. Nat. et Iconogr. des. Ins. Coléop.* (*Mon. du genre Clytus*), p. 37, pl. 8, fig. 46 (1841); *Clytus vicinus*, Lap. et Gory, l.c. p. 38, pl. 8, fig. 47; Gahan, *F.B.I.* Coleopt. vol. i, Ceramb. no. 270, p. 241 (1906); Steb. *Ind. For. Rec.* ii, 11 (1909).

Habitat.—Siwaliks, North India; Salween River, Tenasserim. Gahan gives Bhutan; Calcutta; Deccan.

Trees Attacked.—Sál (*Shorea robusta*): Siwaliks, United Provinces; Teak (*Tectona grandis*): Wutgyi, Salween River, Tenasserim.

FIG. 235.
Xylotrechus smei.
Tenasserim.

Description.

Beetle.—Brown above, with a greyish or yellowish pubescence covering the head and most of the prothorax, and forming bands and spots on the elytra placed as follows: (1) A transverse band on each at the base, followed a little behind by (2) a short transverse spot; (3) a narrow band which begins near the scutellum, passes close to the suture, diverges a little from it posteriorly, and at a short distance before the middle curves outwards to the side, thence it bends forward a little before reaching the margin; (4) a narrow, obliquely transverse somewhat wavy band, placed a little behind the middle; (5) an apical band, which is slightly produced forwards at the suture. Body beneath marked with spots or bands of whitish pubescence. Vertex of head marked with a fine carina, which divides anteriorly into two finer carinae; front with four carinae, the lateral ones oblique or slightly curved; the intermediate two converge downwards and unite so as to form a single median carina on the lower part of the face. Prothorax rounded at the sides, widest behind the middle, narrowed gradually in front, more strongly towards the base, slightly raised along middle of disk; marked with two rounded dark brown spots on the disk and a smaller one on each side. (*Descr. after Gahan.*) Length, 11 mm. to 17 mm.; breadth, 3 mm. to 5 mm.

The species varies in colour and to some extent in the markings. In some cases the derm is of a yellowish-testaceous colour in parts, in others almost entirely dark brown. The pubescence in life is almost invariably ashy grey in my experience. The post-median band of the elytra is often interrupted or broken up into spots and occasionally almost disappears.

Life History.

Owing to an unfortunate mistake made in the identification of specimens of this insect some twelve years ago, it became confused with the *Xylotrechus* of the Himalayan oak, *Quercus dilatata*, leading to the supposition that there were two species of *Xylotrechus* infesting this oak. So far as my present observations and information go only one, *X. Stebbingi*, is known.

X. smei, quoted variously as *Clytus vicinus* and *Xylotrechus vicinus*, pseudonyms which gave rise to the mistake, infests the sál-tree in the Siwaliks. Notes on the life history of this insect were made by me some years ago, the insect being identified as *Clytus vicinus*. The beetles appear on the wing in June, and not improbably again at the end of September or in October, there thus being two generations of the insect in the year. The eggs are laid in sickly trees or newly felled ones, but always in the upper part in the crown or larger branches, or in the main stem of younger trees. The larvae live in the bast and sapwood, eating deeply into this latter when infesting the smaller branches. When full-fed they go further into the wood and eat out a small elongate pupal chamber (cf. fig. 237 (3)) which is more or less parallel to the longitudinal axis of the branch or stem. Here they pupate. The beetle, on maturing, crawls up the tunnel, eats a hole in the bark, and escapes.

Larvae of varying size but mostly quite small, taken numerously in tops and large branches in January, pupated in May and issued in June of the same year. I am of opinion that these June beetles lay eggs which hatch, and the resultant larvae become full-fed in September, a fresh generation of beetles issuing in October. I also took this insect in all its stages of larva, pupa, and beetle from a recently felled large teak-tree at Wutgyi on the Salween River in Tenasserim on 7 March 1905. The tree, according to the villagers, had been felled from a month to six weeks before. As some of the larvae had not only reached full size, but pupated, and the beetles were nearly ready to issue (one actually was mature), the period must have been longer, provided that the eggs had not been laid in the tree before it had been felled. It is perhaps most probable that the eggs were laid on the tree in November or December, which would indicate that there are two life-cycles in the year, since one generation of the beetles issues some time in March.

In Tenasserim the grubs were found feeding in the bast and sapwood, eating out irregular shallow tunnels which are always tightly packed with excreta ; when full-fed the grub bores down half an inch or so into the sapwood, and then carries the tunnel parallel to the long axis of the tree, slightly enlarging it to form the pupal chamber. In its method of pupating it greatly resembles the *Xylotrechus* found infesting the *Terminalia tomentosa* in the same locality (p. 353).

Damage Committed in the Forest.

These small longicorns have the power, like the small buprestids, of at times increasing in very large numbers, and young growth thus suffers very severely by their attacks, whilst the older trees have their crowns seriously diminished owing to the number of branches killed off.

When the beetle seriously infests young growth the trees should be cut out and burnt.

Xylotrechus Stebbingi, Gahan.

REFERENCES.—Gahan, *F.B.I.* Coleopt. vol. i, Ceramb. no. 274, p. 244 (1906); Steb. *Ind. For. Rec.* ii. 9 (1909).

Habitat.—North-West Himalaya; Kilba, Bashahr State; Jaunsar; Naini Tal, Almora. Gahan gives North-West Himalaya, Bashahr State (E. P. Stebbing), Tibet.

Tree Attacked.—*Quercus dilatata* (moru oak). Kilba, Bashahr; Naini Tal, Almora.

Description.

Beetle.—Brown; head and prothorax clothed with a greyish pubescence; the prothorax with four small brown spots in a transverse row across the middle, two dorsal and two lateral. Elytra subglabrous, testaceous brown, narrowly covered with grey pubescence at the base, marked with some small spots of ashy-grey pubescence which form three interrupted bands—one near the base, another just before the middle, the third midway between it and the apex; the apex also narrowly bordered with ashy-grey. Body beneath covered with grey pubescence, a rather large posterior spot on each of the metathoracic episterna ashy-white. Head with the lateral carinae oblique, slightly curved, extending below almost to a level with the lower margin of the eyes; front narrowed between the eyes, furnished with two prominent convergent carinae which are united below. Antennae less than half the length of body; third joint slightly longer than the first. Prothorax widest behind the middle, very slightly narrowed in front, strongly narrowed towards the base; disk with a median asperate carina, which is broader and more strongly raised behind than in front. Femora rather strongly thickened; the hind pair extending a little past the apex of the elytra. First joint of hind tarsi twice as long as the second and third united. Length, 12 mm. to 18 mm.; breadth, 3¼ mm. to 5 mm. (*Descr. after Gahan.*)

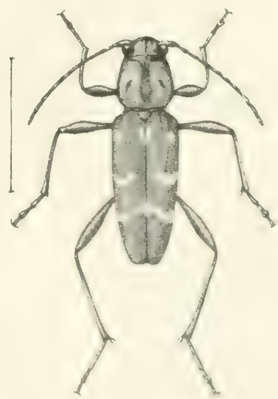


FIG. 236.
Xylotrechus Stebbingi, Gahan. N.W. Himalaya,

Larva.—Whitish yellow, elongate, the segments of the body more or less of the same size, decreasing gradually posteriorly. Head black. Length about 25 mm. when full-grown. (See fig. 237 (1, 1*a*).)

Life History.

The larva of this insect feeds entirely in the bast and outer sapwood of the moru oak. I have not as yet taken it in *Q. incana*. The grub grooves both bast and sapwood, eating out large irregular galleries in the long axis of the tree (fig. 237 (2)). Occasionally the gallery is quite straight, but it is more often irregular and serpentine; the larva, however, appears to confine itself to the layer of wood between the long straight medullary rays,

and more especially so in its young state. The larval gallery is always tightly packed with the wood refuse and excreta ejected by the larva, and is about 5 in. to 8 in. in length, with an average breadth of $\frac{1}{5}$ in. On becoming full-grown, the grub bores down into the sapwood at an angle for about half an inch to one inch, and then eats out a pupal chamber parallel to the long axis of the tree (fig. 237 (3)). Both chamber and entrance-gallery in the wood are kept quite free of wood-dust and excreta. When mature, the beetle crawls up the entrance-tunnel in the wood, bores through the bark which overlies it, and leaves the tree.

Larvae in various stages up to nearly full-grown and full-grown were taken from trees in Naini Tal towards the end of May. Several of these grubs had already bored down into sapwood and constructed the pupal chambers and commenced to pupate.

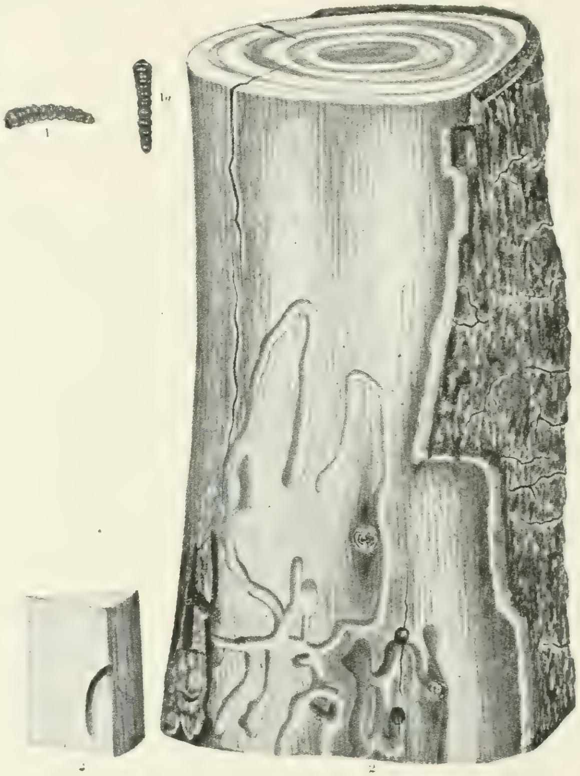


FIG. 237.—Section of stem (with bark removed) of *Quercus dilatata* showing the galleries of the larvae of *Xylotrechus Stebbingi*, Gahan, in the bast and sapwood (2); 1, 1*a*, larvae; 3, pupal chamber in sapwood (all reduced $\frac{1}{2}$).

The beetle appears on the wing towards the end of July and in August, the pupal stage lasting from six weeks to two months. As the beetle issues so late in the season, I think it is improbable that there is more than one generation of the insect in the year. It is possible that the beetles issue at intervals (as the larvae mature)—through a part of July, August, and into September. The larval stage is thus about nine months.

I first obtained larvae of this insect from oak-trees near Kilba in the Bashahr State in 1901. I had asked the Range Officer to watch some trees for me, and he forwarded me some beetles from the trees the following August.

Damage Committed in the Forest.

This little beetle does not commit the serious damage to the timber occasioned by *Lophosternus hügelii*, since the pupal chamber is only constructed in the inner layers of the sapwood. When in numbers, however, it is capable of entirely destroying the bast layer of young trees, and in this way, when

accompanied by the bark-borer *Dryocoetes hewetti* (p. 545), it must be looked upon as a serious pest.

Protection and Remedies against the Oak Longicorn Borers.

Remedial measures in the forest for these longicorn beetle pests are somewhat difficult to prescribe, as the insects are normally distributed throughout the area occupied by the tree. A point, however, which should always be borne in mind is that the egg is deposited by the beetles on the bark of green standing sickly trees or newly felled ones, and that the young grub requires at first the soft bast layer to feed upon. Consequently barking the trees soon after felling will ensure the destruction of the *Xylotrechus* beetles, since their grubs spend the whole of the period of their existence in this stage in the bast layer and outer sapwood. The barking of the trees leads to the drying up of the bark and the death of the grubs. Trees infested by the parasitic *Loranthus vestitus* are most liable to be attacked by this beetle.

Xylotrechus quadripes, Chevr.

(*The White-Borer or Coffee-Borer.*)

REFERENCES.—Chevr. *Mém. Soc. R. Sci. de Liège*, xviii, p. 315 (1863); Dunning, *Trans. Ent. Soc.* 1868, p. 126 and fig.; *Ind. Mus. Notes*, i, 61; Gahan, *F.B.I.* Ceramb. i, no. 276, p. 245 (1906).

Habitat.—Mysore, Coorg, South Kanara. Gahan gives Madras, Coorg, Assam, Sylhet, Burma, Siam, Tonkin.

Tree Attacked.—The Coffee (*Coffea arabica*).

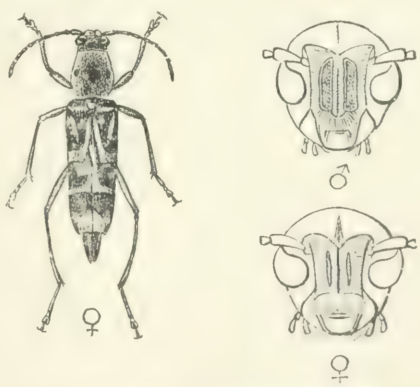


FIG. 238.—*Xylotrechus quadripes*, Chevr. ♀. Madras. *F.B.I.*

Description.

Beetle.—Black with a greyish or yellowish pubescence covering the greater part of the head and prothorax and forming bands on the elytra; disk of prothorax with a rounded subasperate black spot in the middle, and a smaller black spot at each side. The elytral bands consist of the following: (1) a basal band; (2) a short oblique band that points towards the shoulder in one direction, and towards the angle of the next band in the other; (3) a band which begins a little behind the scutellum, runs close by the suture for a short distance, then diverges from it posteriorly and turns outwards to the side; (4) a transverse or slightly oblique band behind the middle which gradually widens towards the suture; (5) an apical band with oblique front margin. Body beneath with a dense white pubescence formed into spots in parts.

♂ Face with a more or less distinct median carina, between which and each of the lateral carinae there is an elongated, very finely rugulose, opaque black area, with slightly raised edges. Head femora extending beyond the apex of elytra. ♀ Face with a single raised line or carina on each side midway between the median and lateral carinae. Hind femora not reaching past the apex of elytra. Length, 10 mm. to 17 mm.; breadth, 3 mm. to 5 mm.

Larva.—Yellowish white, stout and thick, tapering but slightly. Has the ordinary longicorn appearance, and is about one inch in length. Is a fairly active grub.

Life History and Damage.

This *Xylotrechus* is the well-known coffee-borer of Southern India, and white-borer of Ceylon. The insect practically exterminated the coffee industry in the sixties. The grubs tunnel up the stem of the plant and are often in such numbers that the weight of the crown causes the stem to break off short owing to its inability to support it. An inspection will show that the stem is a mass of tunnels entirely riddling it, most of the wood having been removed by the grubs. The tunnels are not clearly visible on the surface of a newly cut stem at first owing to the fact that they are entirely packed with the wood-dust and excreta of the grubs.

In a coffee plantation not far from the Nilgiris in South Kanara, which I inspected with the owner in August 1902, we found some of the bushes full of larvae, the grubs being in the main stems and thicker branches. The presence of the grubs is easily discovered. My companion took hold of a bush and swayed the whole thing backwards and forwards. If it was badly infested by the borer it broke off short, the fracture occurring in the main stem below the head. Bushes infested in this manner invariably died, he informed me. Here in the middle of August the stems were full of larvae, each tunnel having a squarish section. The eggs are apparently laid on the bark by the beetle in autumn, and there may be two generations in the year. (See Dr. Bidie's report to the Madras Government, 1869.)

Good cultivation and not too dense a shade are considered the best preventives. The planters on the West Coast of Madras prune infected bushes or clear out and burn acres of infested trees in a severe attack. This is done in June and July. Some also scrape the trees with the back of a knife in winter or early in the year, and those who do this appear to suffer less from the borer. It is probable that in this process the eggs laid on the bark are scraped off and thus killed.

Xylotrechus gahani, Stebbing, sp. nov.

Habitat.—Charduar Rubber Plantation, Darrang, Assam.

Tree Attacked.—*Ficus elastica.* Charduar.

FIG. 239.
Xylotrechus gahani, sp. nov. Assam.

Description.

Beetle.—Elongate, narrow, with a yellowish pubescence covering most of head and thorax and arranged in bands on the elytra. Head and antennae black; disk of prothorax reddish purple, sides black; elytra black, with the following yellowish bands: (1) a basal)(-shaped band consisting of a semi-lunar band on each elytron meeting on suture; (2) a transverse band behind the middle, gradually broadening towards the suture and not meeting lateral margin; (3) a narrow apical band. Pygidium black. Head finely rugose on vertex, slightly channelled between the eyes; front with a sparse yellow pubescence, the median carinae on front converging and meeting just above the clypeus. Prothorax very convex, narrow in front, widest just above posterior angles, sides rounded, rather coarsely asperate. Elytra widest at base, sides slightly rounded to

posterior coxae and then gradually constricted to apex, latter broadly truncate; surface dull, rugose. Under-surface rather densely pubescent, the pubescence greyish, densely clothing the thoracic parts and forming bands on the posterior halves of the abdominal segments. Legs black, pubescent; hind femora extend by about one-fifth their length beyond apex of elytra. Length, 15.2 mm.; breadth, 3.7 mm.

Life History.

Little appears to be known on the subject of the life history of this insect. I took a specimen ovipositing on a branch of a rubber plant some ten feet in height in the nursery at the Charduar Rubber Plantation on 10 April 1906. The beetle was clinging to a branch, and I watched two eggs laid. The eggs are small, semi-elliptical, semi-globular, translucent bodies.

Xylotrechus sp.

Habitat.—Salween River, Tenasserim.

Tree Attacked.—*Terminalia tomentosa.* Wutgyi, Salween River, Tenasserim.

Beetle.—Elongate; lightish brown with pale white markings; prothorax with sides angled medianly; elytra not wider than prothorax at base. Pygidium exposed, pointed; legs very long. Owing to immersion in bad spirit the beetles were in too poor a state of preservation to enable them to be identified.

Larva.—Yellowish white in colour, fairly stout and thick, short, with a rather well-developed head and thoracic segments. Blunt posteriorly.

Pupa.—Whitish yellow in colour. Has the ordinary appearance of a longicorn pupa.

Life History.

The beetle first appears on the wing in the early part of March, and continues issuing throughout the month in Tenasserim. All stages of the insect—larva, pupa, and beetle—were taken in a felled green tree, the tree having been cut early in the past cold weather, probably in November or early in December. Others were subsequently taken from a standing, nearly dead tree. The egg is laid in an interstice of the bark of the tree. The young larva on hatching feeds at first in the cambium layer, and then in this and the sapwood, hollowing out a widening tunnel which grooves both. This tunnel is packed with the excreta of larva and wood-dust. When full-fed the grub bores vertically down into the sapwood (or at a slight angle) for about half an inch to an inch, and then eats out a small narrow chamber of about its own length in the sapwood parallel to the long axis of the tree. This tunnel is about three-quarters of an inch in length, and the larva pupates in this. In some of these chambers mature beetles were found on 7 March 1905. Others had already left and were probably ovipositing in fresh trees in the forest. This generation would appear to take about five months to pass from egg to beetle. There are consequently probably at least two life-cycles in the year.

Damage Committed in the Forest.

The beetle was in large numbers in the felled tree examined, and a large portion of the cambium had been removed from it. When the insect infests trees in numbers, it is quite capable of ringing the stem by removing the bast and consequently killing the tree.

CALOCLYTUS.

A member of this genus is one of the common dry-bamboo beetle-borers.

Caloclytus annularis, Fabr.

REFERENCES.—Fabr. (*Callidium*), *Mant. Ins.* i, p. 156 (1787); id. (*Clytus*), *Syst. Eleuth.* ii, p. 352 (1801); Lap. et Gory (*Clytus*), *Hist. Nat. et Iconogr. des Ins. Coléopt.* (*Mon. du genre Clytus*), p. 102, pl. 19, fig. 121 (1841); Chevr. (*Chlorophorus*), *Mém. Soc. R. Sci. de Liège*, xviii, p. 290 (1863); Gahan, *F.B.I.* Ceramb. i, no. 299, p. 261 (1906); Lefroy, *Ind. Ins. Pests*, p. 375 (1909).

Habitat.—Backerganj; Calcutta; Pusa; Dehra Dun. Gahan gives Northern India, from the North-West to Assam; Burma; Siam; thence extending northwards to China and Japan, and southwards through the Malay Peninsula and Archipelago to New Guinea.

Trees Attacked.—Dry bamboos (*Bambusa* spp.). Backerganj (Sen Gupta), Calcutta; Pusa (H. M. Lefroy); Dehra Dun.

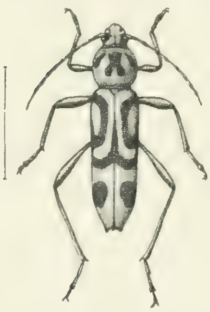


FIG. 240.
Caloclytus annularis, Fabr. Bengal, United Provinces.

Description.

Beetle.—Rather densely covered above with yellow pubescence, varied with dark brown or almost black markings (usually brown when alive) arranged as follows: three spots on the prothorax, one median bifurcated posteriorly, and one obliquely oval on each side before the middle; two bands and a rounded spot on each elytron, the first band somewhat elliptical in form, with its longer axis extending from near the shoulder to the middle third; the second band transverse, sub-median, curved forwards along the suture about half-way to base, expanded at its outer end into an oblique spot which reaches to the elliptical band in front and is united to it by a narrow point; the rounded spot lies about midway between the sub-median band and the apex, and approaches more closely to the outer margin than to the suture. Body beneath with a dense whitish pubescence that covers almost the whole surface in the ♂, and forms more or less extensive spots at the sides in the ♀. Prothorax marked with a fuscous spot on each side near the base, in addition to the black spots on the disk. Elytra truncate and quadridentate at apex. Length, 10 mm. to 5 mm.; breadth, 2½ mm. to 4 mm. (*Descr. after Gahan.*)

Life History.

The life history of this common longicorn is very simple. The beetles appear on the wing in May or June, and on into the commencement of July in the more northern limits of its habitat. The eggs are laid in cut bamboos which have already lost a portion of their sap, i.e. bamboos which were felled in the forest in the preceding cold-weather months, the beetles ovipositing in them in the following May or June. The larvae, on hatching out, bore into the tissues of the walls of the bamboo, and eat out tunnels which have little definite direction, and often appear more or less to intersect or cross the one with the other. These tunnels are packed with wood excreta and dust. When full-fed the larva eats out a slightly wider chamber in the wood, and changes into a pupa in it. The grub feeds in the bamboo from June till March, resting for a month or two during the winter months. The pupa and resting stage of the beetle lasts about two months.

Damage Committed.

This beetle, as Lefroy notes correctly in *Indian Insect Pests*, where the brief note on the life history corroborates my investigations and those of others, is to be found commonly issuing from bamboos used in the thatching of roofs. The bostrychid borers (*Dinoderus*), *Stromatium barbatum*, and this *Caloclytus* are probably responsible for the chief boring work done in the bamboo structure of thatched roofs in India.

The method of preserving the bamboos from these attacks has been already alluded to under *Dinoderus minutus* (p. 135).

Ranger Sen Gupta whilst a student at the Imperial Forest School at Dehra Dun obtained this beetle from bamboos in Backerganj in June 1902.

I have noted it since the year 1898 as common in Calcutta and Dehra Dun.

Caloclytus sp. prox. signaticollis.

Reference.—Determined as close to *signaticollis*.

Habitat.—Goalpara, Assam.

Tree Attacked.—Sál (*Shorea robusta*). Goalpara, Assam.

Description.

Beetle.—Elongate, slender, with short antennae. Canary-yellow, with a circular black spot on the dorsal surface of the thorax, and wavy transverse bands of the same colour on the elytra. Head black behind, with a yellow pubescence covering the front. The canary-yellow colour is caused by a thick, short pubescence. The black lines on the elytra consist of an ellipse in the shoulder and two transverse lines, one placed medianly and the other near the apex. Under-surface canary-yellow. Length, 13.2 mm.

Fig. 241.
Caloclytus sp. prox. *signaticollis*. Assam.

Life History.

I cut a dead specimen of this beetle from the sapwood of a large branch of a newly-felled sál tree in Goalpara, Assam, in May 1906. Old larval galleries showed that the grubs feed in the cambium and sapwood until full-fed, when they bore down at an angle for an inch or so into the sapwood, and hollow out a pupal chamber in this and pupate in it.

Hyagnis.

Hyagnis fistularius, Pasc.

Reference.—Pasc. *Jour. of Ent.* ii, 280.

Habitat.—Satara, Bombay. Also reported from Port Natal.

Tree Attacked.—*Anogeissus latifolia*. Satara (Young).

Beetle.—Small, yellowish brown, mottled with black specks; the elytra with a transverse dull white patch inclined inwards towards apex in apical half. Head deeply cleft on front; antennae with 1st joint swollen, 2nd very short, 3rd longer than any of rest, the joints decreasing in length from 4th. Prothorax with a slight longitudinal median carina; irregularly punctate. Elytra wider than thorax at base, slightly constricted from base, wider medianly, thence constricted and rounded apically; striate and finely and irregularly punctate, the striae most prominent in lateral portions; the whole of upper surface clothed with a short stiff yellow or grey pubescence. Under-surface of abdomen clothed with a long, dense, yellowish pubescence. Length, 8 mm. to 12 mm.

Description.

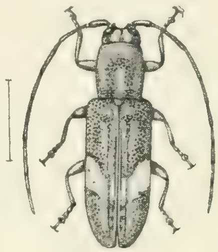


FIG. 242.
Hyagnis fistularius, Pasc. Satara.

Life History.

This insect was taken from the bark of *Anogeissus latifolia*, and is thought to be one of the longicorns whose grubs attack the bast and sapwood of this tree in Satara. The insect was taken by Mr. Young, the Range Officer, in June 1909.

CHAPTER XVI.

PHYTOPHAGA (*continued*)—Family CERAMBYCIDAE (*continued*).

LAMIINAE.

Head in front vertical, or bent inwards well below the thorax ; last joint of the palpi pointed at the end ; fore tibiae generally with a groove beneath.

The number of the Lamiinae known as pests in the forests is not so numerous as the preceding group. One or two of the genera, however, have earned a considerable notoriety owing to the damage done by certain species.

As a rule the larvae feed in the interior of the stems or roots of sappy trees, or infest seedlings and young trees only, burrowing up the centre of the stem or branch, and eating out a tunnel which may entirely hollow out the stem, or branch, or root. This method of attack is easily distinguishable from that of the Cerambycinae, where the grubs feed in the bast and outer sapwood, and only penetrate deeper into the wood to pupate.

Monohammus.

The following species is excessively common throughout the country.

Monohammus nivosus, Wh.

References.—Wh. *Proc. Zool. Soc.* p. 409 (1858) ; Lefroy, *Ind. Ins. Pests*, p. 376 (1909).

Habitat.—Sub-Himalayan tract from Ganges to Nepal ; Central and Southern India ; Burma ; Ceylon.

Tree Attacked.—Ak (*Calotropis gigantea*).

Fig. 243.
Monohammus nivosus, Wh.
India.

Description. **Beetle.**—Short, stout. Rich brown in colour, the head and greater part of elytra silvery-white owing to the presence of a dense short pubescence of this colour ; antennae yellowish ; legs brown or covered with a yellowish grey pubescence ; under-surface clothed with a very short dense white or yellow pubescence. Head rather deeply cleft on front between insertion of antennae. Prothorax with sides produced medianly into a sharp point ; the disk raised in irregular tubercles with a transverse "collar" basally. Elytra considerably wider than prothorax at base, constricted to apex, apices separately rounded ; the brown spaces, not clothed with the white pubescence, with rough imbrications. Length 20 mm. to 26 mm.

Life History. This beetle appears on the wing from March to May. The egg is laid on the stem of the tree, and the grub on hatching out bores into the stem and tunnels upwards in the centre. The grubs when about one-third grown will always be found to have reached this position. Several grubs are at times to be found

tunnelling at different levels up one stem, and they undoubtedly have the power of killing the tree. It is only on account of the fibre-producing capabilities of the tree that the insect is likely to be of any importance so far as the *Calotropis* is concerned. Lefroy mentions (in *Indian Insect Pests*, p. 376) that "the beetle is to be found practically wherever this plant grows."

COELOSTERNA.

Coelosterna scabrata, Fabr.

(*The Babul-Root Boring Longicorn.*)

REFERENCES.—Fabr. *Spec. Ins.* i, p. 224; *Ind. Mus. Notes*, vol. i, p. 88 (1889); Coelosterna spinator, *Ind. Mus. Notes*, vol. iii, p. 144 (1894); Steb. *Ind. For. Bull.* (new ser.), no. 12, 2 (1912).

Habitat.—Oudh; Berar.

Trees Attacked.—Babul (*Acacia arabica*): Berar, Bundelkhand; Sál (*Shorea robusta*): Oudh; Casuarina (*Casuarina equisetifolia*): Kandikuppa, Madras.

This insect has been confused with *S. spinator* in its attacks on babul (*Acacia arabica*). In *Indian Museum Notes* the specimen identified as *C. spinator* was said to be remarkably like *C. scabrata*, and should only be placed as a variety of that insect. This specimen was sent from Berar as infesting babul there. The insect which has been committing the most serious depredations to the babul plantations in Berar during the past three to four years has been unquestionably identified as *C. scabrata*. More recently the insect appeared in the same connexion in the Kalpi experimental plantation in the Bundelkhand Division in the United Provinces. This is also one of the pests which destroy casuarina in Madras.

Description.

Beetle.—A dull, yellowish brown in colour, the sides of the body and legs being bluish; the nodes of the antennae joints black, the rest of the joints reddish brown or bluish; the elytra are yellowish grey set with a large number of black spots varying in size from a pin's head to minute specks. The beetle is a bulky insect from an inch and a quarter to an inch and a half in length. The head is channelled on the vertex; the prothorax has a prominent lateral median spine on each side. The scutellum is large and bluish in colour. The elytra are smooth, broader than prothorax at base, and have a blunt median spine at apex. Pl. xxv, fig. *c*, shows the beetle.

Larva.—An elongate, thickish grub with a brown head and black mandibles; the prothorax is enlarged, with a hard yellow plate dorsally; the abdominal segments are distinct, the middle ones largest; the fourth to the tenth have each a prominent black spiracle on the lateral edges. Length, 2 in. to $2\frac{1}{2}$ in. Fig. *a* shows the larva side view, and a^1 the front of its head.

Pupa.—The pupa is pale reddish-yellow colour, its prothorax showing the lateral prominent spine; the upper abdominal segments show three black spiracles placed laterally on their dorsal surfaces. Figs. *b*, b^1 show a dorsal and ventral view.

Life History.

(a) *In the Sál.*—From reports received on the subject the life history of this insect has appeared so contradictory as to have led to considerable confusion. As long ago as November 1888, Captain E. Wood, Conservator of Forests, Oudh, reported that a beetle was doing some damage to sál coppice saplings in the rains by ringing them. He wrote a paper on the subject which

appeared in the *Indian Forester*,* and in which this beetle was identified as *Coelosterna scabrata* at the Indian Museum. *Indian Museum Notes* † contains a reference to Captain Wood's report of the insect. "The habits," the note says, "of this species are, no doubt, very similar to those of the allied American Hickory Twig Borer (*Oncideres cingulatus*, Say.)," and the life history of the latter is then detailed.

The life histories of Indian insects cannot, however, in the majority of instances examined, be based upon those of American species. Consequently, at present we have no further data on the life history of this insect in connexion with the sál-tree than those ascertained by Captain E. Wood, and described in the *Indian Forester*. Although I have taken specimens of the insect on the wing in the sál forests of the United Provinces, I have never had the good fortune to find the insects at work.

Captain Wood's note is as follows :—

I have noted, as stated in some of my reports to Government, that the succulent shoots of coppice sál saplings were ringed by some insects in the rains, because the marks left in October–November showed that they were comparatively recent, and the dead upper portions showed that the leaves had reached maturity ; it was probable also that the ringing was done by flying insects, as the tops of the shoots (within a foot or two of the top) were the parts usually affected. As the ringing of the bark, and the consequent destruction of the portions of the stem above it, render the coppice shoots liable to be crooked or to bifurcate, I desired, if possible, that the insect might be discovered. . . . The insect was found at work in the evening (so reports the Forester), and a specimen of the ringing was also sent. It is probable that the insects use the soft bark for their own food . . . and nearly every coppiced stem is thus ringed.

It is possible that the grubs live in the portion of the shoot above the girdle, but the point was not ascertained.

(b) *In the Babul.*—We now turn to the question of the life history of the insect in the babul (*Acacia arabica*), where it is proving itself a pest of the first importance. Observations made on their life histories appear to show that the majority of longicorn beetles which have proved to be forest pests do not feed in the mature or beetle stage of their existence.

The babul-root boring longicorn would appear to be an exception to this rule, since it has been reported so often as feeding on the bark and stripping it off the young plants, or of ringing the young plants. We have seen that the buprestid beetle *Psiloptera fastuosa* actually does commit this damage, feeding on the bark of leading shoots and young twigs (p. 199 : pl. xi). I do not think, however, that it had been definitely ascertained that the longicorn actually feeds here in the case of the Berar infestation of the pest. Latterly, however, the beetle has been reported from the Kalpi Plantation in Bundelkhand, the *Psiloptera* not apparently being present. The *Coelosterna* appears in that locality as early as September (third week), and strips the bark from the young trees, often apparently ringing them (pl. xi).

The beetles are found on the wing in Berar early in October, and it is during this month that the bark is eaten or peeled down the stems of the young plants by this insect and its buprestid companion.

* *Indian Forester*, vol. xiv, p. 503 (1888). † *Indian Museum Notes*, i, p. 88 (1889).

The eggs are evidently laid on the stems towards the end of the month in Berar, perhaps earlier in Bundelkhand, and always low down towards the bottom of the stems on the sapwood from which the bark has previously been removed. The larva on hatching out at once tunnels down to the centre of the stem and then feeds there, gradually, as it grows older, working down to the root, the base of the stem and the thicker portions of the main roots being entirely hollowed out by the grub, as shown in pl. xxv, figs. *e*, *f*. The larval tunnel is kept almost free of wood-dust and excreta to enable the grub to move up and down in it, and to get rid of this mass of refuse it eats out a hole through the bark just above ground level and ejects the mass through this. It is this hole and the mass of tell-tale wood-refuse in heaps on the ground beneath it which serves to indicate with certainty the presence of the grub in the trees. The hole, of course, also serves the purpose of aerating the larval tunnel down in the roots beneath the surface of the soil. The work of the grub first begins to make itself obvious in December, its attacks during November, owing to its small size, not being so evident. The grub, according to Mr. Scrinivasalem, remains active and at work until the middle of July, when, the monsoon having well set in, it pupates. Before pupating the grub blocks the now entirely hollowed-out thicker part of the root with a mass of ligneous root-fibres (figs. *e*, *g*), these being torn off from the inner sides of the walls of the cavity and wedged into a mass both at the bottom and top of the space it intends to pupate in, which is about twice its own length. It then changes to a pupa and remains in this stage till about the end of August. If the roots are examined in September, the immature beetles will be found in the cavity, as shown in figs. *d*, *e*, their coloration being very vivid, but the outer parts still soft. Towards the end of the first week in October the insect is mature, and bites its way through the mass of fibrous material blocking the tunnel above it, crawls up the hollowed-out root till it reaches the refuse-hole made by the larva above ground, and crawls out of this ; or it may bite a way out of the stem for itself.

Damage Committed in the Forest.

The first report of this *Coelosterna* proving a pest to babul was made by the Conservator of Forests, Berar, in July 1892, when he forwarded specimens of the beetle through the Director of the Imperial Forest School at Dehra to the Indian Museum, Calcutta, with the information that "the insect committed considerable damage to the plants, the larva being said to enter the stem some three or four inches above the ground, and to tunnel through the roots to such an extent as eventually to cause death." As there were no specimens of the insect in the Indian Museum, the beetle was forwarded to the British Museum, where Mr. Gahan identified it as *C. spinator*, which he considered to be a variety only of *C. scabrata*. In *Injurious Insects*, p. 68, I drew attention to this point, and suggested that should the habits of the two beetles prove the same, the beetle would be best alluded to under the name of *C. scabrata*. In June 1903, whilst in charge of the Indian Museum at Calcutta, I received specimens of this beetle from Kandikuppa,

Madras, where they were reported as eating the leaves and young stems of casuarina. It would appear that the beetle was engaged in stripping off the bark of the young trees when taken.

Nothing further appears to have been reported on the insect until, in November 1907, Mr. S. Scrinivasalem Maidu, Divisional Officer of the Buldana Division in Berar, forwarded me specimens of beetles, reporting that they were devouring the bark of leading shoots and young twigs of babul in the Bhongarn Reserve of his division. At my request the Divisional Officer kindly kept a careful watch on the plantation to observe whether the grubs which he mentioned in the same communication as being constantly seen tunnelling in young babul-trees had any connexion with the beetles. In August 1908 Mr. Scrinivasalem was able to forward to Dehra specimens of babul stems and roots containing grubs and pupae, and beetles were obtained in numbers from them, the insects proving to be *C. scabrata*.

Meanwhile from the Amraoti Division, Berar, specimens of a longicorn grub, reported as tunnelling into the roots and lower portion of the stems of babul, were received from Mr. Pandurang Narayan, Extra Assistant Conservator of Forests, in April 1908. He said that the grub was generally noticed from February to May. Some beetles subsequently obtained proved to be *C. scabrata*.

In November 1908 an insect committing depredations to babul was reported from a new locality. Mr. T. Carr, I.F.S., forwarded me two beetles received by him from the Ranger in charge of the Kalpi Plantation in Bundelkhand in the Eastern Circle of the United Provinces, with the report that they had commenced to strip the bark from young babul in the plantation. The beetles proved to be *C. scabrata*.

From the above remarks and the notes given on the life history of the insect, it will be sufficiently obvious that *C. scabrata* is a pest of the first importance, since it is capable, in the absence of a knowledge of its life history and a capacity for being able to distinguish its attacks, of obtaining a complete mastery over a young plantation, and this means the partial or total loss of that plantation. The damage committed by the beetle is to both stem and root, and plants seriously attacked are certain to die. The insect only infests growing trees. Immature larvae in cut stems die off.

Protection and Remedial Measures.

Now that the life history of this pest is well known, methods of combating it are fairly simple. Whether the resultant loss from its attacks in a plantation is heavy or small will depend entirely on the amount of supervision the plantation receives and the capacity of those in charge of it for immediately marking down an attack in a tree as soon as it has started. Attacks both to stem and root are easily seen—to the stems as the bark is peeled off when egg-laying; to the root by the wood-dust and excreta ejected from holes near its base by the boring grubs.

Infested trees should be dug out and either burnt *in toto*, root, stem, and branch, or the parts slit up, and the grubs, pupae, or beetles they are found to contain killed on the spot.

In small plantations the stems of the saplings should be painted for six inches below and one foot above ground with a mixture of cow-dung and clay to which paraffin has been added. This will prevent the beetles ovipositing on the stems.

Out in the forest badly infested trees are easily marked down, and they should be felled and cut up and burnt, for if left standing they serve as centres from which the infection would spread to unaffected trees.*

Batocera.

The genus includes one of the commonest of the large longicorns to be found throughout the plains of India, and a pest of considerable importance.

Batocera rubra, Linn.

References.—Linn. *Syst. Nat.* ed. x, p. 390; Stebbing, Note on the Duki Fig-tree Borer, *For. Bull.* no. 10 (1907).

Habitat.—Baluchistan: Duki, Loralai (Col. C. A. Kemball), Fort Sandeman (Major Roome *et mihi*); Dehra Dun; Pusa (Lefroy).

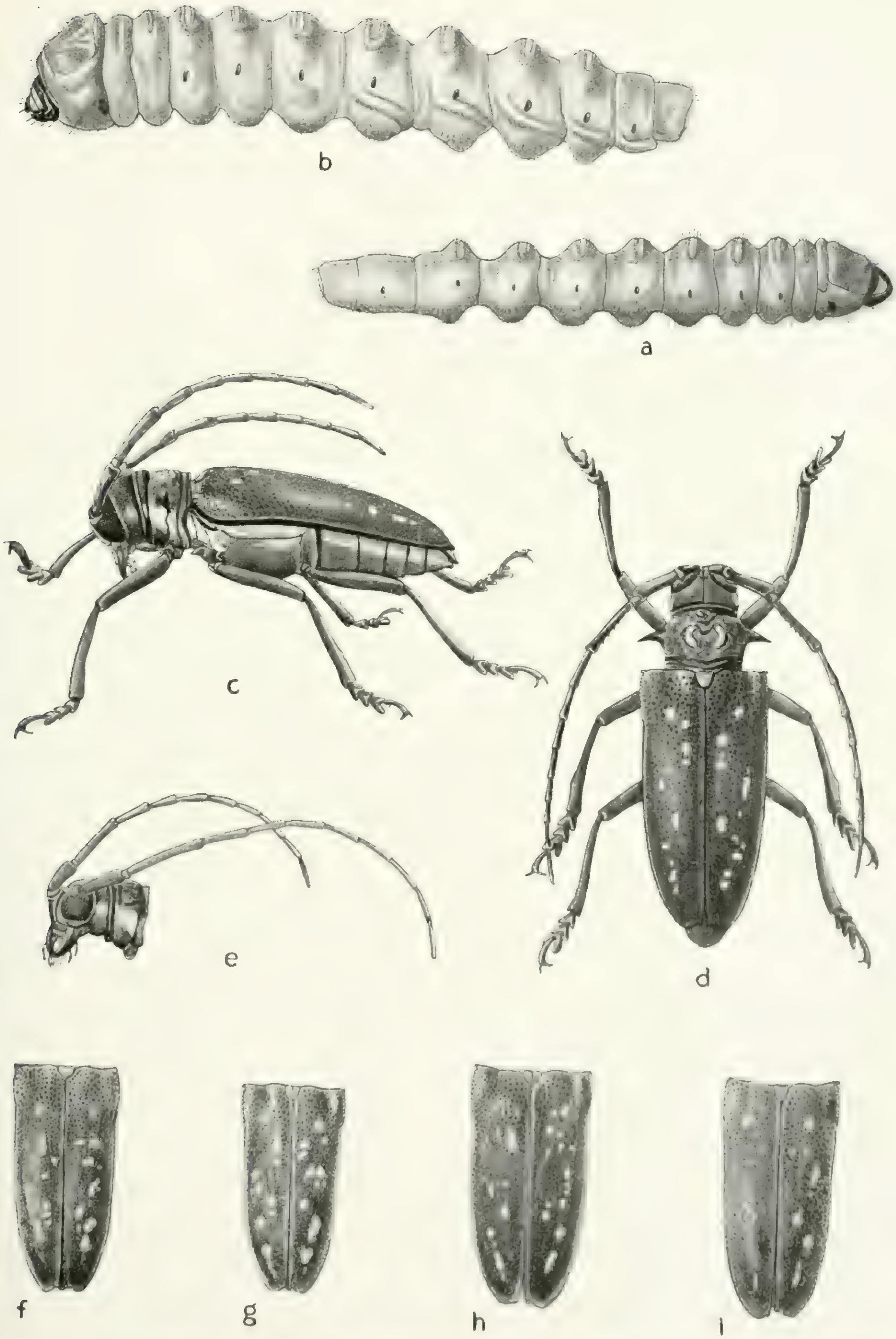
Trees Attacked.—Fig-tree (*Ficus carica*): Baluchistan; Mango (*Mangifera indica*).

Beetle.—A large stout insect with long antennae and legs. Black or ferruginous yellow, dull, with a series of dirty yellowish spots on the elytra. Head vertical, mandibles long and powerful. Antennae black; a row of sharp small teeth on inner edge of the third joint. Prothorax transversely ridged on the anterior and posterior edges with irregular ridges and wavy lines on the intermediate portion. At the sides the thorax is produced medianly into a sharp pointed tooth. Four orange spots are placed circularly on the dorsal median area. Elytra truncate at the base with well-marked shoulders which end in small sharp teeth; they are constricted and rounded at the apical end. The basal quarter is studded with small, shining, rather scattered projecting elevations which are largest at the base and decrease in size anteriorly. Rest of surface smooth. Two irregular longitudinal lines of yellow spots, seventeen or less in number, on each elytra. In some specimens these spots form a well-defined line near the apex of the elytra. The last segment of the body is left exposed by the elytra. Under-surface black, shining, with a broad lateral white strip running down each side. Legs ferruginous black.

Description.

The male is distinguished from the female by having the antennae longer than the total length of the insect. In the female the antennae do not reach to the apex of the elytra; length, 49 mm. to 56 mm. In pl. xxvi, figs. *c*, *d* depict a side and dorsal view of the female beetle, fig. *e* the head of the male beetle, and figs. *f* to *i* variations in the number of spots on the elytra.

* Since this was written Mr. V. Subramarian Iyer, Acting Forest Zoologist, published the following note on this insect (in *For. Bull.* no. 11, 2nd ser. 1912): "The thick white grubs bore into the wood of the roots of the tree in Nellore and Cuddalore. I found another specimen of *Coelosterna spinator* in North Arcot, the damage done by which is probably similar to *C. scabrata.* The existence of this latter in the grub stage was easily detected by the amount of sawdust found near the base of the saplings attacked, which ultimately die. In May and June 1910 I saw traces of this borer in the casuarina plantations of Cuddalore, and I received beetles of *C. scabrata* from Nellore." Mr. Iyer is, however, incorrect in his inference that *C. scabrata* is identical with the unidentified longicorn described under *Lamia* sp. on p. 379



Batocera rubra, Linn. The Duki fig-tree borer. —*a*, *b*, immature and mature larvae; *c*, *d*, female beetle; *e*, head of male beetle; *f* to *i*, elytra of beetle, showing variation in yellow markings. Duki, Loralai, Baluchistan.

Larva.—The full-grown larva is a long, thick, tuberculate, yellowish grub, three and three-quarter inches in length and three-quarters of an inch broad at the anterior end, which is thickest. The head is black, broadest behind, and bluntly pointed in front, the two biting jaws (mandibles) being black. The segment following the head is broad and swollen, dark orange-yellow, the upper surface being hard and horny and shining; the two following segments are narrow; the remainder are slightly narrower than the first, thick, with swollen tubercles on each; the last two taper bluntly. There are a pair of minute feet on each of the first three segments and a pair of swollen tuberculate ones on the fourth to the ninth segments. A transversely elongate brown spot (the breathing opening or spiracle) is situated on each side of the second and the fourth to the eleventh segments. Figs. *a*, *b*, show a larva two-thirds grown and a full-grown grub.

The life history of this insect was first completely worked out in the years 1905–7 by Colonel C. A. Kemball, Political Agent in Loralai, Baluchistan. The beetle was found to be committing serious damage to the fig-trees in the Duki Garden in his Agency. It was subsequently found in other parts of the province.

Life History in the Fig-tree in Baluchistan.

The beetle commences to issue from the trees about the middle of June, and is found throughout the remainder of the month and on through July. It is apparently most plentiful in July. This period of six to seven weeks, then, is the egg-laying period. The eggs have not yet been discovered, but they are probably laid either singly or in little clusters on the outside of the bark of the tree or in incisions made by the beetle in the outer bark so as to reach the softer parts beneath. The number of eggs laid is at present unknown.

The grubs on hatching from the eggs in July or August feed at first in the green sappy portion of the inner bark, and then, as they become larger and stronger, tunnel down into the wood and bore down the centre of the stem or branch in a direction parallel to the longitudinal axis, mining out a gallery which increases in breadth with the growth of the larva. If the grub commences in a branch, it tunnels down the branch until it reaches the main stem, and then tunnels down that. The tunnel is blocked behind by the excreta of the larva, the portion occupied by the latter being full of sap. As it progresses down the stem or branch it eats out at intervals longitudinal offshoots to the outer bark, these longitudinal tunnels serving to admit air into the stem. The sap oozing from these is an indication that a grub is at work inside the stem. The larger branches and the main stem of the fig-tree, including the bottom portion of the stem and the upper thick portion (the crown) of the roots, are the parts of the tree infested by the grub, the galleries eaten out by the mature larva being as much as one and a quarter inches in width and a foot or more in length.

When full-fed the grub pupates in the heart of the stem or upper part of the root, eating out a wide elliptical pupal chamber which it blocks at the open end with a mass of compressed wood fibres, some loose wood fibres occupying the lower end.

The pupa spends three to three and a half months in this stage. The beetle, when mature, bores a circular tunnel straight to the outside of the tree, the large exit-hole being very visible on the outside (see pl. xxvii).

Damage done by the Insect to Fig-trees.

Up to the present it has not been definitely proved that this pest kills the fig-trees. Major Roome, Commandant of the Zhob Levy Corps, informed me that some of his trees in the Levy Corps garden at Fort Sandeman were so badly riddled that one or two were blown down and several others had to be cut out. I myself saw two or three trees in this garden in 1905 which were so full of larvae that it appeared to be only a question of time when they would succumb to the attacks of the insect. Colonel Kemball informed me in 1906 that no trees had so far actually died under the attacks at Duki. It would seem, however, that in this garden the attack had only recently culminated at the time of his report. The insect, occurring but sparingly at first, committed but small depredations, and these remained unnoticed.

We have seen that the grub tunnels chiefly inside the stem and branches of the trees; it is owing to this method of attack, whereby the bast layer remains for the most part untouched, that the trees are not at once killed by the insect. At the same time the strength of a tree containing many boring larvae is naturally sapped and undermined owing to the numerous hollow galleries and tunnels it contains. It therefore becomes but a question of time for the tree to succumb to these attacks; either being blown down by the wind, or falling owing to the stem being no longer capable of bearing the excessive weight of the crown.

It should also be remembered that these trees are in themselves a danger, since by rearing up larvae, which become beetles and lay eggs, they help to spread the infection to as yet unattacked or but slightly attacked trees. The beetles also, owing to their power of strong flight, are able to carry the infection to unaffected gardens and trees.

H. M. Lefroy alludes to this insect (in *Indian Insect Pests*, p. 375) as follows :—

> *Batocera rubra*, Linn., is the large beetle found throughout the plains whose larva is common under the bark of trees; it appears to occur chiefly in decaying bark, and the trees felled in Pusa contained abundance of the large larvae and pupae.

From what has been written above, the question of the protection of the fig and mango trees, and the clearing of infested gardens, becomes a matter of considerable importance.

Protection and Remedies.

It has been said that this insect has a very wide distribution throughout the country. There is little chance, therefore, of stamping it out, and the question of preventing its spreading in the gardens is the one for consideration. It has been shown that from the nature of the attack on the tree the latter

tion of the base of a fig-tree infested by *Batocera rubra*, Linn. The galleries in the wood and the large

will not necessarily die owing to the presence in it of the boring grubs. Only in the event of their being very numerous in it will a tree be likely to succumb to the attack. At the same time we must remember that every infested tree is a source of danger to others as well as to itself, since the presence of only a few larvae in a garden or in a single tree means the future appearance of beetles who will give rise to a progeny greater in numbers than themselves, and will result, in the course of time, in a serious infestation.

My recommendations are, therefore, as follows :—

1. Where a tree is seen to be very seriously infested by the pest and to contain, from the evidence of numerous external holes, a large number of larvae, that tree should be cut out, cut up into sections, and burnt. Particular attention should be taken to ascertain that every portion of the wood is well charred. The period of cutting and burning should be between the end of October and the end of March.

2. Where a tree is not seriously infested, attacked branches, or portions of the main stem, if high up, should be pruned off and burnt, as detailed above. In both cases they should be pruned off below where the insect is seen to be at work, and the pruned spot should be thickly coated with tar. In cutting off heavy branches, the branch should be first sawn off about a foot from its junction with the main stem, the remaining portion being subsequently taken off flush with the stem. This is to avoid the weight of the branch tearing the bark of the trunk (thus causing a wound at which the beetles would oviposit), which usually happens if the branch is taken off flush in the first instance.

3. From the beginning of June to the end of August the parts of trees infested with grubs should be enveloped in muslin (mosquito-netting) bags, tied above and below the area containing the grub. These bags should be inspected daily, and all beetles issuing from the areas so enveloped, who will be unable to escape owing to the netting, should be killed. Crushing them against the stem of the tree without de aching the netting will be sufficient. The daily inspection is necessary, otherwise male and female beetles may issue in the same bag, pair, and the female may lay eggs on the confined area before she is killed. Should this take place the work and supervision entailed will be of no avail, since the eggs will hatch into grubs and these latter will carry on the attack in the tree. It was by means of such bags that Colonel Kemball had the beetles caught which set at rest the question of the identity of this pest.

4. Between the dates specified in the preceding paragraph a careful watch should be kept in the garden for beetles issuing from parts of trees unprotected by the bags, and all such found should be caught and killed. This inspection should be made in the daytime, and at night with a lantern. The beetles will usually be found clinging to the bark of the trees.

Batocera albofasciata, De Geer.

REFERENCE.—De Geer. *Mém.* v, p. 106, t. 13, f. 16 (1775).

Habitat.—Darrang, Assam.

Tree Attacked.—India Rubber (*Ficus elastica*). Charduar Rubber Plantation, Darrang, Assam.

FIG. 244.
Batocera albofasciata, De Geer. $\frac{1}{1}$. Assam.

Description.

Beetle.—Dull brownish purple or black. The scutellum, and a variable number of spots on elytra, white or yellow; a broad white lateral stripe on under-surface, its inner margin with an irregular scalloped edge; rest of under-surface clothed with a fine, short, dense yellowish pubescence. Sides of thorax produced medianly into a long sharp spine; the disk covered with irregular imbrications; two crescent-shaped orange depressions placed on either side of the median line; transverse elevate lines bounding the anterior and basal margins. Scutellum large, heart-shaped. Elytra broadest at base, the shoulders produced into a spine, the sides constricted to apex, latter truncate with a spine at either corner, the sutural one the longest; basal third set with a number of raised, smooth, shining black points; the white spots placed longitudinally and irregularly, varying in number and size from three or four to seven, the median one being the largest. Length, 29 mm. to 36 mm.

Larva.—Elongate, rather flat, yellow with a black head, and orange prothorax.

Pupa.—Pale yellow, rather narrow body, rather acute apically.

A beetle of this insect was found mature in the pupal chamber in *Ficus elastica* on 9 April, the insect having just commenced to cut its way out of the tree. The beetles probably fly from about the middle to the third week of April in Assam. The eggs are laid on the bark of the rubber-tree or at wounds. The larva on hatching out tunnels through the bark till it reaches the bast, and feeds here at first, and then goes deeper and eats out a winding gallery, which eventually reaches into the heart-wood, and is carried more or less parallel to the long axis of the tree. These galleries are of some length, and go right into the interior of large trees. When full-fed the grub enlarges the end of its tunnel in the heart-wood and pupates here. The larval tunnel is packed with wood refuse and excreta. Before pupating the grub packs the top and bottom of the pupating chamber, which is parallel to the long axis of the tree, with masses of long fibres pressed rather closely together. The beetle, when mature, bores straight out of the tree, the exit-tunnel being at right angles to the long axis. These exit-orifices are clearly seen on the bark, and serve to denote that the tree is infested with this beetle.

On 9 April I took a few full-grown larvae, a number of pupae, and some mature and immature beetles in a tree. This would seem to show that there is only one generation of the insect in the year, that the eggs are

laid some time about the end of April and during May, that the larvae spend some nine months in this stage, and that the pupal stage is from six weeks to two months, the grubs pupating in January or February.

Damage Committed in the Forest.

A number of dying rubber-trees had been felled at Charduar shortly before my arrival, and an examination showed that they had been badly attacked by this insect. The beetle apparently seeks out diseased or dying trees in which to oviposit. The danger of the insect in a rubber plantation is that when numerous its attacks in the wood would gradually undermine the vitality of the tree, and also lead to its being liable to be blown down by wind.

Trees badly infested by this pest should be cut out, cut up, and burnt. If left standing they only serve as infected centres which will breed out numbers of beetles who will subsequently attack other trees.

Batocera titana, Thoms.

(*The Mango-tree Longicorn Borer.*)

REFERENCE.—Thoms. *Mon. Arcan. Nat.* p. 82 (1857).

Habitat.—Chicacole, Ganjam, Madras: Taunggyi, Southern Shan States.

Trees Attacked. — Mango (*Mangifera indica*): Chicacole, Ganjam, Madras (S. Cox); ? Oak (*Quercus griffithii*): Taunggyi (H. W. Watson).

Description.

Beetle.—A large heavy beetle of a yellow or greenish-yellow colour, mottled with blackish markings and orange spots; under-surface clothed with a short silvery-grey or yellowish pubescence, as also the legs; antennae brown, 1st joint black; the vertex of head black, covered with a yellow pubescence. Antennae inserted on anterior edge of head, 1st joint very stout and long, 2nd very short, 3rd longest of all and serrate on inside, 4th shorter than 3rd but longer than rest, serrate on inside, but less so than 3rd, rest more or less equal. Prothorax broader than long; sides produced medianly into a sharp black spine bent downwards, a broad collar on anterior edge, the disk irregularly elevate with a short orange mark on either side of a median elongate black line. Scutellum large, heart-

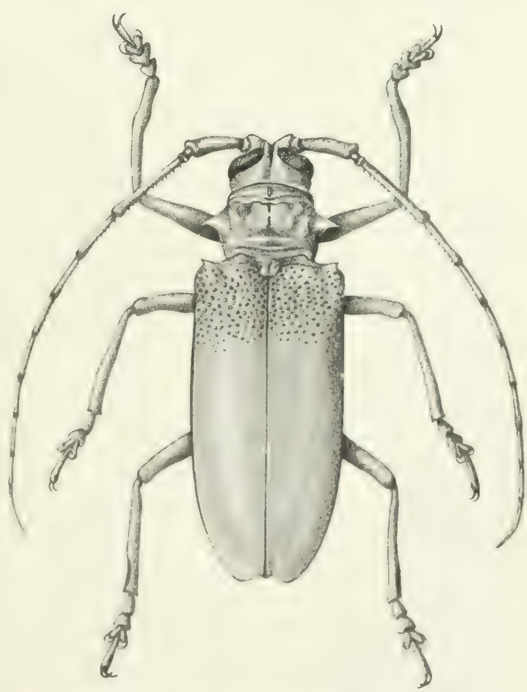


FIG. 245.—*Batocera titana*, Thoms. ♀. Madras and Southern Shan States.

shaped, orange. Elytra broadest basally, constricting apically, the suture being produced into a short spine; the shoulders produced, the basal fourth studded with a number of raised black prominences; six or more irregular-sized orange spots, three in basal fourth, four largest placed medianly on disk, five and six smaller placed the one below the other in apical third. Length, 57 mm. to 75 mm.

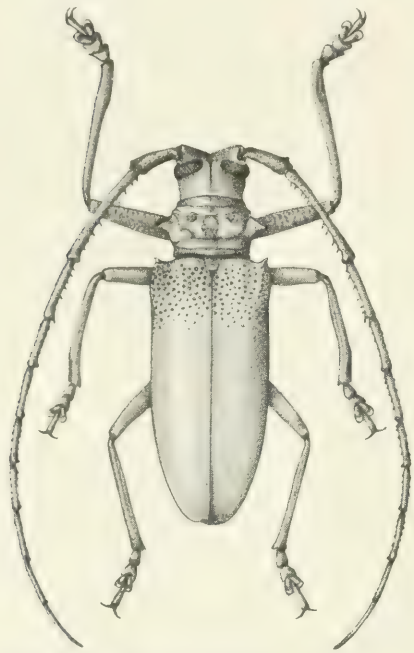


FIG. 246.—*Batocera titana*, Thoms. ♂. Madras; Southern Shan States.

Life History. The beetle makes its appearance on the wing in Madras about the middle of July and probably throughout August. In the Southern Shan States a specimen was taken by Mr. Watson in September. The eggs are laid at wounds on the trees or deposited so that the young grubs hatching out can rapidly and easily reach the cambium layer. The grubs do not, however, remain here, but soon tunnel down into the wood of the tree and eat out a long gallery parallel to the long axis of the branch or stem attacked in a manner similar to that already described for *Batocera rubra* in the fig-tree. In order to aerate the tunnels thus made in the wood, branch tunnels of considerable size are carried at right angles to the main one until they pierce the bark. These bores, from which wood-dust and excreta are ejected by the larva and from which tell-tale streams of sap ooze down the bark, make the attack readily recognizable. The grub remains feeding in the wood throughout the remainder of the year and up to March in the year following, the damage in the last two or three months of the larval stage of existence being particularly noticeable in the trees. In the main trunk of the tree the grub feeds in the bast, grooving deeply into the sapwood, the whole of the cambium layer of the tree being removed when the larvae are numerous. When full-fed it tunnels into the heart of the tree and eats out there a large pupating-chamber which is plugged up at either end with wood fibres and dust. Mr. S. Cox, I.F.S., found the insect in all its stages, except the fully mature beetle in the first week of March, the full-grown larvae being the most numerous. The grubs, then, pupate at about this date. The pupal stage and resting stage of the beetle must take from three to three and a half months, as a beetle was taken crawling up the exit-tunnel from the pupating-chamber by Mr. T. Reilly, I.C.S., on 19 July. It may be considered as definitely ascertained, therefore, that the life-cycle of the insect takes a year to pass through, that the eggs are laid on the trees in July and August, and that the

period during which the damage is being done to the trees is from August to March.

Damage done to the Tree.

During the first week in March 1907 Mr. H. T. Reilly, the Head Assistant Collector, drew the attention of Mr. S. Cox, District Forest Officer, to the damage being done to mango-trees at Chicacole in Ganjam. The trees in question were graft mangoes, and particularly valuable ones, and well known in the district. Chicacole is famous for its mango topes, the number of trees in the Taluq being roughly 11,100, the area of the topes being estimated at about 3,780 acres. The value of the fruit of these trees, which is exported to Calcutta, is considerable.

FIG. 247.—Portion of the stem of a mango-tree showing larval galleries in sapwood and entrance-holes to pupal chambers of *Batocera titana*, Thoms. Ganjam, Madras.

As a result of subsequent observations carried on by Messrs. Reilly and Cox at Chicacole, and of my staff and myself at Dehra Dun up to November 1909, the serious infestation of these trees by longicorn beetles and their grubs has now been sifted out.

The matter has been highly complicated owing to the fact, as pointed out by Messrs. Reilly and Cox, that the mangoes appeared to be infested by more than one species of longicorn and some other insects. It was definitely ascertained from the first specimens procured in March 1907 that there was at least a longicorn and buprestid at work, larvae of both of them having been taken from the wood. Subsequent investigations and specimens sent to Dehra definitely proved that there were at least two distinct longicorns present, the *Batocera titana* and *Plocæderus obesus*. From the mango logs kept under supervision in the breeding cage at Dehra Dun the following beetles were bred out: The buprestid *Belionota prasina* described on p. 217; *Plocæderus obesus*, p. 295; and *Æolesthes holosericea*, p. 301; so that there are no less than one buprestid and three longicorn beetles infesting the mango-trees at Chicacole. The importance of being fully acquainted with the life histories of all these insects becomes evident when it is remembered that any one of the species by itself is probably capable of killing the tree.

A specimen of this *Batocera* was sent to me in September 1909 by Mr. H. W. Watson, who stated that he found it on a *Quercus griffithii* at Taunggyi in the Southern Shan States.

Protection and Remedial Measures.

Since, as Mr. S. Cox pointed out, the chief object in the case of a fruit-tree is to preserve it, and not to cut it out unless absolutely necessary, it is by no means easy to prescribe measures of protection. Of course the most imperative one is that those in charge of the gardens should be acquainted with the life histories of the aggressors—when the beetles appear and the eggs are laid, and the months during which the larvae feed. A great deal could be done in the matter by a systematic collection of the beetles with lanterns at night. In the case of infested trees, attacked branches should be cut off, split up, and the grubs in them killed. It is not sufficient to merely cut off the branch, as that will not result in the death of the grubs inside. Nor is it sufficient to fell a diseased tree. We have seen that from logs sent to Dehra the beetles were bred out. Seriously infested trees should be cut down during the cold weather, cut up, and burnt *in toto*. When any holes are seen on the stem of a young tree dilute kerosene should be injected through them, and the holes should then be plugged and coated with tar.

In the case of valuable topes the remedies prescribed on p. 365 for *Batocera rubra* will apply in a general manner, the cold-weather months being the period during which they should be carried out.

MEGES.

Meges marmoratus, Westw.

REFERENCE.—Westw. *Cab. Or. Ent.* p. 11, t. 5, f. 1, ♂ (1848).

Habitat.—Taunggyi, Southern Shan States.

Tree Attacked.—Oak (*Quercus griffithii*) (H. Watson).

Beetle.—An easily recognized beetle owing to its large size and the curious white or greyish-white and brown markings of the elytra. The head has a sharp longitudinal median line on vertex; the antennae are very long and stout, 1st joint very much swollen, 2nd short, 3rd longer than any of the others; the sides of thorax are produced into a large thick and sharp-pointed spine; the disk with a black triangular or diamond-shaped mark in centre. Elytra broad, rather flat on disk, smooth, moderately shining, with several broad longitudinal striae. Under-surface clothed with a short dense yellow or yellowish-green pubescence. Length, 70 mm.; breadth, 24 mm.

Description.

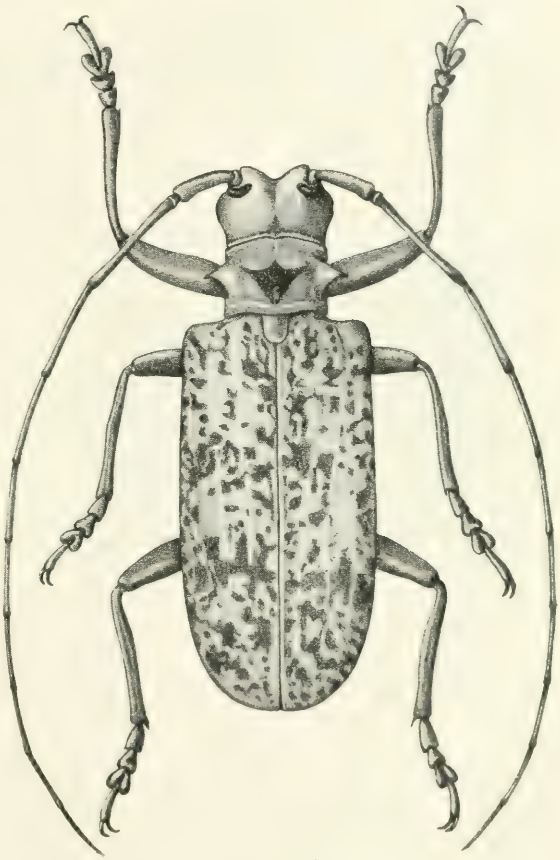


FIG. 248.
Meges marmoratus, Westw. Southern Shan States.

A specimen of this fine large longicorn beetle was sent to me by Mr. Watson from the Southern Shan States in September 1910. He had taken it from the oak *Quercus griffithii*, the insect being found on the outer bark of the tree.

APRIONA.

Apriona germari, Hope.

REFERENCES.—Hope, Gray's *Zool. Misc.* i, 28 (1831); Stebbing, *Depart. Notes* vol. 1, p. 25 (1902).

Habitat.—Shahdera Plantation, near Lahore, Punjab.

Tree Attacked.—Mulberry (*Morus indica*). Shahdera Plantation.

Beetle.—Mature beetle clothed with a golden-brown pubescence. Elytra are rough and scarped at their anterior surfaces, where they are dotted with small black raised points. Colour is more golden on the under-surface. Legs same colour as elytra, tarsus slightly darker. Specimens with this colouring were found in 1897. In 1898 one beetle taken resembled in form the above, but differed in coloration. The colour is a dirty yellow, but the elytra have several

Description.

white blotches on them, and there are two bright orange spots on the thorax. It differs also on the under-side in having a broad white marginal band round the abdomen extending to the head, thus being unlike the uniform colouring of the other specimens. Length, 46 mm.; breadth, 13 mm. The first described specimens were identified for me by Mr. C. O. Waterhouse, of the British Museum, as *A. germari.* I have not seen the 1898 beetle. The difference in markings may be due to a difference in sex only. Fig. 249 shows: *a*, the larva; *b*, the pupa; and *c*, the imago.

FIG. 249.—*Apriona Germari*, Hope. *a*, larva; *b*, pupa; *c*, beetle. $\frac{1}{1}$. Changa Manga.

Larva.—The larva is a long, white, thick grub, with a well-developed head, powerful mandibles, and large thoracic segments. It is legless, and when fully developed is about 3 in. in length and ½ in. across the thoracic segments.

Life History.

The notes on the life history of *A. germari* are drawn up from careful observations made by Mr. B. O. Coventry, I.F.S., when in charge of the Shahdera Plantation, from investigations made by myself during a visit paid to the area, and from the correspondence on the subject by Messrs. C. G. Rogers, I.F.S., and Coventry, published in the *Indian Forester.**

The larva of this beetle infests stems of the mulberry (*Morus indica*). Its presence in the trees had been known for some years (Mr. Rogers mentions finding it in 1892), but neither the pupae nor beetles were discovered at the Shahdera Plantation till specimens of both were taken by Mr. B. O. Coventry in 1897.

Larvae of all sizes are present in the stems at all times of the year, this clearly denoting that they take a year or more to mature. Both pupae and beetles were found in the middle of July, but none of the latter are said to be discoverable in the stems in August. It is thus probable that the beetle's flight-time is at the commencement of the rainy season. As the perfect insect is not to be found later on in the year, it probably at once pairs and lays eggs on the bark of the stems. The young grubs eat their

* *Ind. Forester*, vol. xxiv, pp. 203, 204, and 341–345; xxv, pp. 68, 69.

way in and remain for a time boring in the sapwood, and then as they get stronger go into the heart-wood and tunnel up and down this. Some tunnels I inspected were 7 ft. to 8 ft. and more in length. As soon as the tunnel enters the sapwood, branch tunnels to the outer surface of the bark are gnawed out at intervals for aeration purposes, and the course and direction of the tunnel within the stem can be traced by these holes on the outside, the holes and the offsets to the outside increasing in circumference with the growth of the grub. Careful search has failed to show that more than one larva is ever present in any one stem, and therefore it must be considered probable that the beetle lays but one egg on any one tree. The position on the stem where it is laid would appear to vary, as Mr. Coventry considers it to be always high up, whereas my own observations on some cut stems showed that in these cases the larva had commenced its tunnel in the sapwood at the foot of the tree. Mr. Coventry wrote:—

> "The larvae, commencing high up, burrow down the entire length of the stem, and often a considerable way down one of the main roots. . . . After reaching its lowest limit the larva appears to hollow out a chamber of sufficient size to enable it to turn round, and then burrows straight up the stem again, sometimes following the old gallery, and sometimes striking a new one."

It is not improbable that the chamber here referred to is made to enable the grub to rest for a period during the coldest part of the winter, but this opinion requires corroboration. By far the longest part of the tunnel, including all the portion with a large diameter, is to be found in the heart-wood, the larva seeking this and leaving the sapwood as soon as its mandibles are strong enough to enable it to bore into the former.

Damage Committed in the Forest.

Although the larva and its work had been known for some years at the Shahdera Reserve, a sailaba plantation on the banks of the Ravi about five miles from Lahore, Punjab, it was not until 1897 that beetles were obtained by Mr. B. O. Coventry, from which the insect was identified as *Apriona germari*.

Mulberry stems are very badly infested by this beetle, which confines itself to this tree, and does not attack its companion the sissu. The eggs are most usually laid on the main stems of young living coppice shoots, about three to four years old, and $2\frac{1}{2}$ in. to 3 in. in diameter, and the insect grows in size with the development of the tree. Attacked trees can be recognized owing to a rusty red stain running below each air-hole made by the larva, the stain being caused by the trickling down of sap from these holes; also very often by the presence of sawdust at the foot and on the bark of the trees. The attacks of the larva do not kill the tree, but the galleries bored up and down the stem ruin the wood for timber purposes, and at Shahdera the mulberry can only be sold as firewood. A large proportion of the young trees were infested in 1901, and the old ones mostly bore the marks of previous attacks in the unsightly wounds, often of large size, which were to be seen on

their stems. These wounds have originated from the air-holes of the larva and the large exit-hole made by the beetle. Decay sets in at these points, and is probably accelerated by rainwater. These large wounds are not to be found on trees containing living larvae.

Protection and Remedial Measures.

Mr. Coventry has suggested that the only practical remedy is to cut out all attacked stems and collect and destroy the larvae. The damage chiefly originates in the young compartments, and the removal of attacked stems would be in the nature of a light thinning, which would be beneficial rather than detrimental to the growing stock. This opinion entirely agrees with my own, and, being that of an officer who has held charge of the plantation, is, I conclude, a feasible one. We have already seen that the stems containing larvae are easily recognized; each stem cut down should be carefully cut up, including the roots if necessary, until the larva is found and destroyed before a fresh one is felled. This work requires the most careful supervision, as upon its being done thoroughly will depend the stamping out of an attack completely. The larvae found should be made to tally with the infected stems cut. A curious feature of the Shahdera attack was the fact that the beetle was not present in the Changa Manga Plantation, only forty miles away. Careful search during several years failed to bring to light a single case of attack on the mulberry at the latter place, and the wood of the tree can thus to a certain extent be sold as timber. The danger of the beetle spreading to Changa Manga was very great, and it was probably only the fact that its life history was worked out and understood, and that measures were taken in time to stamp it out at Shahdera, that prevented the beetle from making its appearance in and getting a hold over the trees at Changa Manga.

Apriona cinerea, Chev.

REFERENCE.—Chev. *Rev. Zool.* p. 416 1852).

Habitat.—Dehra Dun, N. India.

Tree Attacked.—Mulberry (*Morus indica*).

Description.

Beetle.—Elongate, rather narrow. Uniform greyish to greyish yellow, due to a dense pubescence; the surface beneath black. Head with a median longitudinal impressed line on vertex, the front cleft between the eyes; 1st joint of antenna swollen and rather long, 2nd very short, 3rd longer than 1st and 2nd, 4th about equal to 1st and 2nd together, rest sub-equal. Prothorax wider than long, the sides produced medianly into a long spine pointing downwards, the surface raised in more or less parallel transverse irregular wavy ridges. Elytra with shoulders produced into a spine; basal fifth of surface studded with a number of small raised shining black points; the sides constricted apically, the apex terminated in three small spines placed somewhat close together. Under-surface clothed with a short yellowish pubescence. Length, 28 mm. to 49 mm.

I have taken this beetle on several occasions in Dehra Dun and neighbourhood, stripping the bark off the leading shoots and twigs of young mulberry plants in a manner very similar to that in which *Psiloptera fastuosa* and *Coelosterna scabrata* treat the babul (*Acacia arabica*) (cf. pl. xi).

Olenecamptus.

Olenecamptus bilobus, Fabr.

References.—Fabr. *Syst. Ent.* ii, 234; Lefroy, *Ind. Ins. Pests*, p. 373 (1909).

Habitat.—Dehra Dun; Gangetic Plains.

Trees Attacked.—Pakar (*Ficus rumphii*), Gular (*Ficus glomerata*), and Timla (*Ficus roxburghii*).

Description.

Beetle.—Elongate, slender, with very long antennae, more than twice length of insect. Head and greater part of prothorax clothed with an orange pubescence; base of prothorax and elytra red-brown, becoming yellowish brown in apical part of elytra, moderately shining, the elytra with three white spots; under-surface densely clothed with a white pubescence, as also the slender legs. Front of head covered with a white pubescence; basal joint of antennae swollen and coarsely tuberculate, 2nd very short, 3rd equal to 4th and 5th together, rest sub-equal, last longer than those immediately below it. Prothorax set with a number of parallel transverse ridges. Elytra coarsely punctate, the punctures much finer apically; the basal white spot is the largest, the one just above it the smallest. Length, 15 mm. to 24 mm.

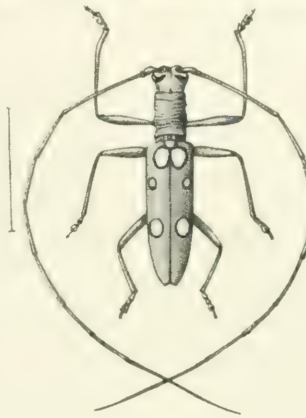


Fig. 250.
Olenecamptus bilobus, Fabr.
United Provinces.

Life History.

The grubs of this beetle are to be found plentifully in Dehra Dun and southwards throughout the plains of the United Provinces and Bengal in the three fig-trees mentioned. They appear to affect old decaying trees, and I have not found them myself in young, green, healthy trees. The beetle appears on the wing in the hot weather and at the commencement of the rains. Lefroy (*Indian Insect Pests*, p. 376) mentions the beetle as common on pakar, gular, and other figs in the plains.

Olenecamptus sp. nov.?

Reference.—Specimen in too imperfect a state for detailed description.

Habitat.—Satara, Bombay.

Tree Attacked.—*Anogeissus latifolia*. Satara (Young).

Description.

Beetle.—Elongate, slender. Dark red-brown, elytra lighter-coloured; an elongate white irregular stripe placed laterally on thorax; a series of white spots and bands on elytra, as follows: (1) a large spot basally with a small one slightly behind; laterally (2) an oblique irregular-edged band medianly with an elliptical spot a little behind it; (3) a narrow oblique spot just below apex with a small one above and nearer suture. Vertex of head with a fine median line, finely punctate. Prothorax much longer than wide, transversely channelled and striate, basal margin black. Elytra wider than thorax at base, sides parallel in basal half, thence constricted to apex, apices separately rounded; regularly and somewhat coarsely punctate, punctures denser laterally; the apical fourth with several rather prominent striae which are less prominent basally.

Under-surface dark brown to black, punctate; abdominal segments reddish brown, with a close fine white pubescence. Legs brown, lower two-thirds of thickened femora black. Antennae damaged. Length, 15 mm.; breadth, 3.5 mm.

This beetle was taken from beneath the bark of an *Anogeissus latifolia* tree in Satara by Mr. Young, the Forest Ranger, at the beginning of March, the beetle appearing on the wing some time during that month.

Thysia.

Thysia wallichii, Hope.

REFERENCE.—Hope, Royle, *Himal.* p. 55, t. 9, f. 5, 6 (1839).

Habitat.—Assam; Goalpara.

Tree Attacked.—? Sál (*Shorea robusta*). Kachugaon, Goalpara, Assam.

Description.

Beetle.—Stout, thickset, and robust, with long powerful legs. A brilliant green with reddish markings. The antennae have a few whorls of hair (circular brushes) on them. Under-surface brilliant red. Thorax ridged, produced into a blunt point medianly at the sides, smooth. Elytra with well-marked shoulders, thickly punctate; a circular brush of black hair arises from middle on the basal third and a small transverse one at same level near lateral margin; a transverse black band of hair on the middle and apical thirds; legs shining indigo-green. Length, 1⅝ in. The beetle is figured in fig. 17.

Life History.

This extremely handsome cerambycid was taken plentifully on the wing in the Kachugaon sál forests in Goalpara during May. It flies by day, settling in the sunlight upon the bark of green standing or felled trees. The beetle was pairing between 13 and 23 May. I was unable to ascertain definitely where this insect came from. It may, as Mr. Perrée suggests, lay its eggs on the sál, and the grubs may feed in the tree. I myself, however, think it possible that it may prove to be a sál girdler, girdling the branches or leaders of young saplings and laying its eggs in the part girdled. Its life history requires working out.

Xylorrhiza.

Xylorrhiza adusta, Wiedm.

REFERENCES.—Wiedm. *Zool. Mag.* i, p. 182 (1819); *Ind. Mus. Notes*, iii, 5, 47.

FIG. 251. *Xylorrhiza adusta*, Wiedm. Madras.

Habitat.—Madras; Taunggyi, Southern Shan States (H. W. Watson). Also from Ceylon.

Tree Attacked.—*Wrightia tinctoria*. Madras.

Description.

Beetle.—Elongate, rather narrow, easily recognized by the great resemblance of the upper surface to the decaying ligneous strands of rough bark. General colour yellow with longitudinal dark brown or brownish black stripes, the basal portion of prothorax and elytra a rich velvety dark brown or black; the extraordinary coloration of the beetle is due to the thick pubescence which clothes the whole surface, upper and lower, with the exception of smooth black finely punctate areas on the abdominal segments; the pubescence appears in the form of long

hair or tufts on the front of the head and basal joint of antenna, joints 2 and 3 and thighs and tibiae of legs densely pubescent; apices of elytra fringed with hairs, giving them a frayed appearance. On vertex of head, on a median longitudinal line on prothorax, and on elytra, the dense pubescence is placed in the form of elongate yellow or brown longitudinal lines and stripes, the lines curving inwards from shoulders and outwards again in apical fourth. Length, 30 mm. to 55 mm.

Life History.

But little appears to be known on the subject of the life history. *Indian Museum Notes* records that specimens of the insect were sent by the Conservator of Forests, Southern Circle, Madras, who reported that the beetles had been found ringing branches of *Wrightia tinctoria*. The beetle rings stems and branches in a manner similar to that of *Sthenias grisator*, and for the same purpose. This appears to be all the record we have at present of this insect.

The beetle was forwarded to me from Taunggyi by Mr. H. W. Watson with the oak borers *Massicus* and *Neocerambyx*, but the species of tree infested in that locality by the beetle was unknown.

Sthenias.

Sthenias grisator, Fabr.

References.—Fabr. *Mant.* i, p. 136; *Ind. Mus. Notes*, iii, p. 110.

Habitat.—Kurnool, Coimbatore, Coorg.

Tree Attacked.—*Tabernæmontana alba.*

Fig. 252.
Sthenias grisator, Fabr. Madras and Coorg.

Description.

Beetle.—Short, thick, squat, with short legs. Greyish brown with white and brown irregular markings, the insect resembling a piece of mottled bark; a large circular patch or "eye" in the anterior third of elytra, where they are depressed to apex, the eye bordered on basal circumference by a velvety black edge, the apical margin light grey. The mottled appearance of the insect is produced by the different coloration of the dense pubescence with which it is clothed. Head and prothorax are striped with longitudinal ridges of brown and grey; the antennae short, not reaching to end of body. Elytra not much broader than prothorax, depressed behind, the apices truncate; some irregular small black tubercles covered with pubescence in the basal area, a prominent elliptical greyish spot medianly and the "eye"-shaped patch in the apical third. Under-surface a uniform dull greyish brown. Length, 20 mm. to 30 mm.

Life History.

But little is known of the life history of this interesting little longicorn. The oldest specimen in the British Museum was received from Coimbatore with the note that the beetle "gnaws the bark of shrubs and is very destructive." Some thirty years later (in November 1892) the Collector of Kurnool collected some specimens of the beetle which he noticed cutting rings of considerable

depth and about an inch in diameter, completely encircling branches of a *Tabernæmontana alba* tree in that locality. The specimens were sent to the Indian Museum and identified subsequently by Mr. Gahan. The following year the beetle was obtained by the Deputy Conservator of Forests, Coorg, where he had found the beetle girdling and cutting down rose-trees. The Deputy Conservator in his letter wrote: "These beetles cut off the stem clean in one night. . . . Large rose-trees are thus cut down and destroyed. . . . They attack the main stem and despise smaller branches."

No further reports appear to have been made upon the life history of this pest. It is one of that interesting class of insects, the girdling longicorns, the object of the beetle in girdling the stem or branch being to ensure the slow death of the portion above the girdle in which she lays her eggs. It thus affords a supply of fresh sappy bast and sapwood through which the sap is no longer rising for the young larvae when they hatch out. The grubs feed on this, and when full-grown, by which time the branch will have dried considerably, they eat out a pupal chamber and change to pupae. On maturing the beetle bores its way out of the stem or branch and escapes.

Glenea.

Glenea multiguttata, Guér.

Reference.—Guér. *Voy. Deless.* ii, 60 (1843).

Habitat.—Madura, Madras.

Tree Attacked.—*Odina wodier.* Madura.

Description.

Beetle.—Head and prothorax pale or canary yellow, marked with black spots and lines; elytra orange brown, rufous brown, or greyish brown, the apical fourth pale or canary yellow, spotted with black; antennae shining rufous brown, legs orange. Front of head with a black spade-shaped spot placed medianly and a median longitudinal stripe on vertex. Prothorax with four black spots placed one above the other on either side of disk and four others placed on either side laterally; the yellow colour of head and thorax is due to a fine dense pubescence. Elytra impressed at shoulder, dull, striate-punctate, the diskal striae short and only apparent in basal portion; laterally, however, they extend to apex; punctures become less defined in apical portion; from a fourth to a fifth of apical portion covered with a dense yellow pubescence, with three spots of black pubescence, the largest towards base; the outer edge of apex produced into a prominent spine. Under-surface clothed with a dense yellow pubescence spotted with black spots, forming a double row on lateral part of abdomen. Length, 10 mm. to 21 mm.

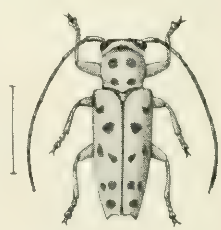


Fig. 253.
Glenea multiguttata, Guér. Madras.

Life History.

A specimen of this beetle was sent from Madura, Madras, with the information that it was taken from beneath the bark of an *Odina wodier* tree. I have no further information about its life history. The grubs probably feed in the bast layer of the tree.

Glenea spilota, Thoms.

REFERENCES.—Thoms. *Class. Longic.* p. 58; Lefroy, *Ind. Ins. Pests*, p. 376 (1909).

Habitat.—Assam, Jalpaiguri; Pusa ? (Lefroy).

Tree Attacked.—Semul (*Bombax malabaricum*). Assam and Bengal.

Description.

Beetle.—Bright canary-yellow, studded with black spots, the coloration due to a covering of a fine dense pubescence; antennae black, legs orange. Head with an elongate median black stripe on front and a narrow transverse one on posterior margin of vertex. Prothorax with four black spots on disk and one on either side. Elytra with seven to nine black spots apiece, the apex truncate, with the outer edge produced into a spine. Under-surface paler, with a crescent-shaped mark on the side of meso- and meta-thorax and the anterior margins of abdominal segments black. Length, 13 mm. to 25 mm.

Life History.

This beetle, which is very common, appears on the wing in the hot weather. It lays its eggs on the bark of the semul, and the larvae on hatching out bore into the bast and feed here and in the sapwood, eating out ramifying galleries, which do not seem to have any definite direction. The grubs appear to prefer that the wood should be dry, and I have not found them in freshly felled green trees. Lefroy also mentions this fact (*Indian Insect Pests*, p. 376), "the larvae being found abundantly in the decaying trunk after the plant has died." The insect cannot at present be considered a pest to the tree, though the grubs may prove of some importance in depots of semul timber, which, owing to its softness, rapidly dries.

UNDETERMINED CERAMBYCIDAE.

Lamia ? sp.

Habitat.—Cuddalore, Madras.

Tree Attacked.—Casuarina (*Casuarina equisetifolia*). Cuddalore, Madras.

Description.

Beetle.—♀ Black, moderately shining. Abdomen very dark red beneath. A short thick beetle with a vertical head. Prothorax sculptured and spined above and at sides, widest in middle. Elytra wider than hind portion of prothorax, parallel to near apex, whence constricted to apex, the elytra thus terminating in a blunt point. Elytra entirely cover the base of body. They are corrugated and spined at their basal portions, and pitted strongly for the rest of their length. First joint of antenna is swollen and well marked. Length $\frac{13}{16}$ in.

Larva.—A thick whitish-yellow grub with blackish-brown head and black mouth-parts (mandibles, followed by a largely developed segment which is slightly darker yellow than the following ones. These latter taper slightly to the tenth, which is half the size of the prothoracic segment. Last two segments smaller, ending in a blunt point. Length, $1\frac{1}{16}$ in. Breadth across the prothoracic segment $\frac{5}{16}$ in.

This is the beetle whose thick white grubs have been reported as boring into the wood of the roots of casuarina-trees at Cuddalore.

Life History. We know little at present about the life history of this insect. The grubs attack and live in the cambium layer and sap-wood of the roots of the tree, and are said never to be found in the stem. Grubs were found in this position on the 1st June, and one mature beetle was obtained from the Talaukoda plantations near Cuddalore. There are no records as to the amount of damage this beetle commits. Since it lives in the cambium layer of the roots it is likely to prove a very serious pest when present in any numbers in a plantation.

Coelosterna ? sp.

REFERENCE.—Stebbing (*Stromatium* ? sp.), *Depart. Notes*, vol. i, p. 379 (1906).

Habitat.—North Coimbatore and Mysore Sandal-wood Areas.

Tree Attacked.—Sandal-wood (*Santalum album*). Coimbatore and Mysore.

During an examination of portions of the sandal-wood areas of North Coimbatore and Mysore in July–August 1902 I found that a longicorn grub was a source of considerable injury to sandal-wood, its tunnels causing a heavy depreciation in the price of the wood, first-class wood being required to be flawless, without holes of any kind in it.

I describe below the life history of the larva which is responsible for the damage. I took a good many grubs, but in no instance was I able to find a beetle. It is, I think, probable that the beetle appears on the wing about November or December.

Larva.—White with a pinkish tinge, thickish, tapering slightly behind. Elongate, consisting of a small head and twelve following segments. Mouth parts black. Thoracic segments yellowish. Length, 1 in. to 1½ in.

FIG. 254.
Grubs of the sandal-wood longicorn borer. Mysore and Coimbatore.

Life History. Grubs differing in size but from two-thirds to nearly full-grown were found in galleries in the stems of the trees in the first week of August. No small larvae were found. From their total size and the length of the galleries bored and from the fact that no young larvae were found in the stems examined, I should think it improbable that they spend over a year in this stage, and the period may be a few months only. Neither the pupal nor the beetle stage of the pest has been yet found.

Method of Attack.—The larvae are to be found either in the main stem or the small branches. An examination of these latter shows that the grub has often started in the branch, bored down it to the main stem, and then down

that. This is not invariably the case, as at times the larval gallery is entirely confined to the main stem. From this it is evident that the eggs are laid by the beetle on the bark of either a branch somewhere close to the main stem or on the main stem itself. These observations are the result of an examination of a number of trees and saplings, some of which were entirely cut up for inspection purposes. The tunnel is tightly packed with the digested wood particles which are passed out by the larva as it proceeds down the stem. These galleries are chiefly confined to the heart-wood of the tree, both in the branch and main stem, and the grub always bores downwards.

Before changing to the pupal state the larva enlarges the gallery slightly, and fills the extreme end with particles of wood refuse and chips. It then turns round in the free space and changes into a pupa. The beetle on maturing bores its way out of the tree by a horizontal hole driven direct through the heart-wood, sapwood, and bark to the outside. The position of this exit-gallery with reference to the larval gallery inside makes it evident that the larva turns round in the pupating chamber before changing to the pupal stage. Whilst boring its gallery the larva may eat out one or two offset galleries to the outside. These are always at right angles to the main gallery and are for aeration purposes only. When the larval gallery is confined to the main stem there will usually be only one of these. If the gallery has started in a branch there will often be two. The insect would appear to confine itself to saplings and young poles.

Between Dhimbun and Kollegal a number of trees and saplings were found to be attacked. The following is a description of a badly infested one which, together with others, was entirely cut up. It is quoted as indicative of what this borer is capable.

The tree had a diameter of 2½ in. at the base and a bole of 15 ft. to the point where the crown commenced. This bole had been attacked in several places, the last gallery running down to within three feet of the base of the tree. Both new and old galleries were visible upon splitting up the stem. These were as follows, beginning at the lowest one :—

1*st*—*New Gallery.*—Contained a living grub just about to pupate in the heart of the stem. Gallery about 18 in. in length bored downwards and confined to the stem only. Gallery slightly winding.

2*nd*—*Old Gallery.*—The eggs were probably laid upon the bark of a side branch. The gallery commenced in this. The young larva on hatching out had bored straight to the heart of the branch and then bored down its centre till it reached the main stem, down the heart-wood of which it carried its tunnel. Length of gallery in main stem, 7 in. The larva had pupated at the end of the gallery, the extreme end of it being packed with wood chips. The rest of the gallery, with the exception of the pupal chamber, was blocked with a dark red hard mass (the heart-wood is reddish consisting of chewed wood. A large hole starting at one side near the upper end of the pupal chamber was bored horizontally through the wood to the outside. This exit-hole was very visible on the outside of the stem.

3*rd*—*Old Gallery.*—This one also commenced in a side branch, the larva working down the branch into the main stem and then down the centre of this latter, finishing up

close to where No. 2 joined the main stem. It did not join this latter. Length about 1 ft. An air-hole had been bored to outside. Exit-hole of beetle bored in the same way as in No. 2.

4th—A New Gallery.—Contained a living larva which was about to pupate. It had enlarged the end of its gallery for this purpose. About 3 in. of the gallery was free of the compressed wood excreta. Length of gallery, 11½ in. Was confined to centre of the stem, and contained one air-hole bored to outside about half-way down. In this case the egg must have been laid by the mother beetle either on the outside of the bark in a crevice or in the softer layer of tissue below.

5th—Old Gallery.—This gallery started at the point where the main stem branched into two or three forks, i.e. where the crown commenced. It began about 1½ in. up one of the forks and then came down the main stem, its total length being from 15 in. to 16 in. One air-hole present. This gallery ended near where No. 4 commenced.

6th—New Gallery.—A tunnel containing a living larva, which ran down one of the forks and ended very near where No. 5 joined the main stem. The grub inside was not more than one-half to two-thirds grown, and the gallery appeared to be still in course of construction. The larva was apparently on its way to the main stem.

From the above we see that there were no less than five tunnels in the main stem (two of which contained living grubs) and one unfinished one in a fork of the crown near where it joined the bole. The tree was alive, but badly stag-headed. It was growing near Osahatti, in the sandal-wood coupe No. 7.

Results of Attack.—Only living trees are attacked by this pest, and it would appear to confine itself to saplings and young poles. The sandal is not necessarily killed by the action of the boring grubs; in fact, unless these latter are numerous the tree is probably but little inconvenienced and the cambium layer soon covers over the old air and exit holes made by the pest. In such cases there is no evidence externally that the tree has been attacked. When it is felled and converted, however, the heart-wood is found to contain the old galleries made by the boring grubs which infested the tree when young, and the value of the wood is thereby greatly lessened, no matter how fine in quality it may be. At other times, however, the tree shows externally plenty of evidence of old attacks. The air-holes and exit-holes are plainly visible, and if the sandal is from any cause sickly and unable to cover these over they begin, under the action of the sun and rain, to "weather," become greatly enlarged, and even at times coalesce. When coalescence takes place the tree will be found to have its centre exposed on one side, perhaps for a distance of several feet, and a considerable amount of "heart" wood will have rotted away under the "weathering" action.

The plantation at Bailur was visited and inspected. The poor character of the growth here was due to other causes, but it was apparent that a number of the trees had been attacked some years previously by a cerambyx borer, not improbably this one. About four thousand badly shaped or dying and dead trees had been cut out the year previous to my visit (1901), or it is not unlikely that the evidence of the pest's work would have been still greater.

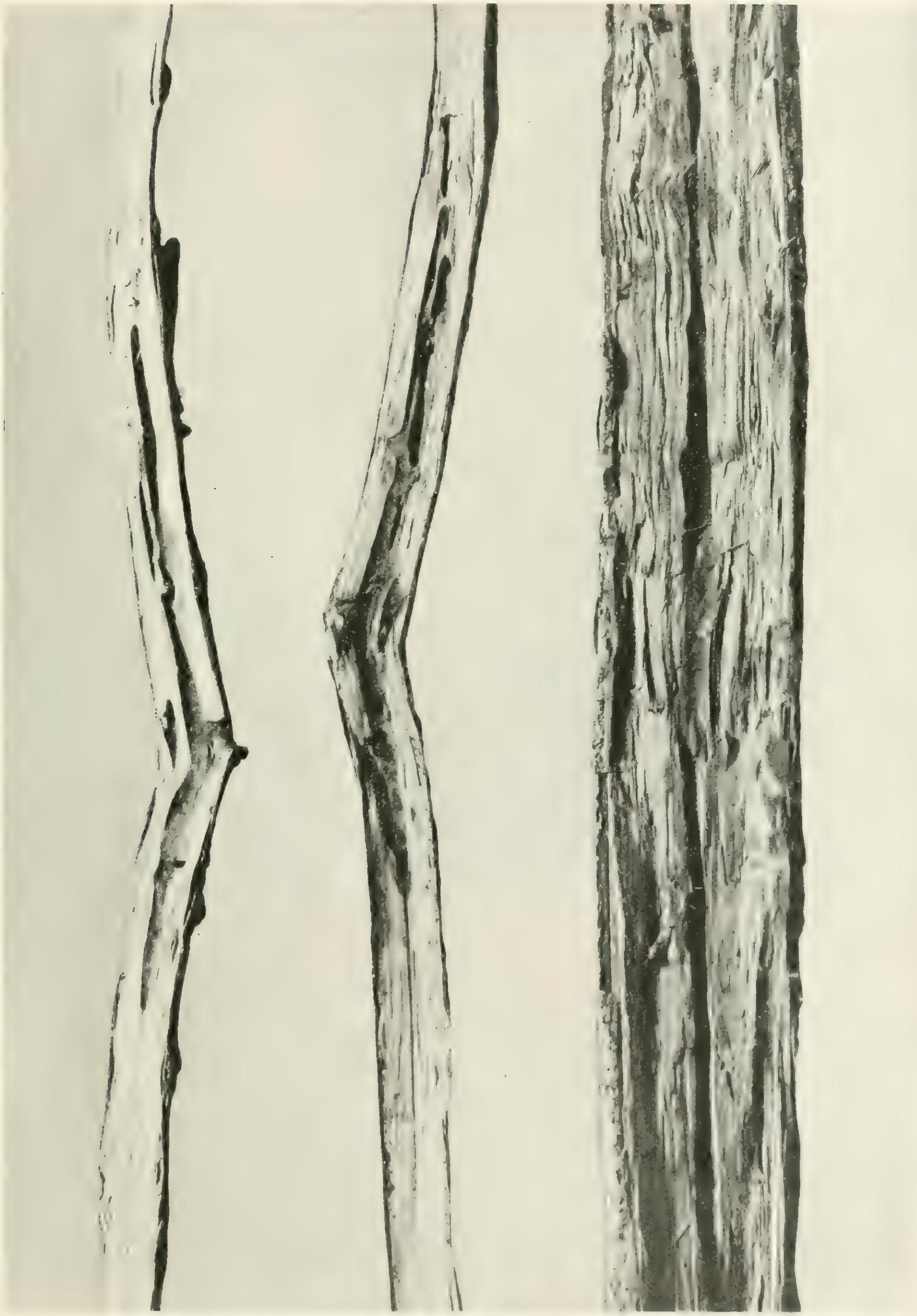


FIG. 255.—Sections of sandal-wood stems showing the longitudinal galleries of *Coelosterna* ? sp. in the centre. North Coimbatore, Madras. August 1902.

Summarizing the above we see that this pest may—

(1) Kill saplings (probably not often).

(2) Bore up the heart-wood of young living trees. Subsequently the vitality of these latter is sufficient to grow over the air and exit holes, thus hiding all trace of the attacks, which are only discovered when the wood is converted for sale.

(3) The exit and air holes may "weather" to such an extent that they coalesce, and thus 50 per cent. or more of the heart-wood of the tree may be destroyed.

During a visit I paid to the Sandal Koti at Bangalore I was able to inspect the damage done to the wood by these insects. Unfortunately, I arrived a week too late to be present at the actual sorting of the year's outturn, which was stored in the godown. Had I been present at this it would have enabled me to inspect many hundreds of logs, and it would have been possible to form some conclusion as to the insects' abundance or otherwise in Mysore. I was shown the various classes of wood, and the system of classification was described. Wood with holes and galleries in it (as shown in pl. iii), even though its quality may be otherwise absolutely first class, is relegated to the third or fourth class, and therefore it is quite possible to calculate the actual monetary loss occasioned by the work of this longicorn. My inspection showed it to be sufficiently great to render the full working out of its life history a matter of the first importance.

Protection and Remedies.

The question of methods of protection against these internal boring pests is a difficult one, and the drastic one of cutting out and burning all infested trees is often the only one that can be recommended. The matter is rendered more difficult in this case owing to the scattered way in which the sandal-tree grows.

We require to know a good deal more about the *Coelosterna's* life history, and firstly the period at which it lays its eggs and how long they take to develop and hatch out the grubs. If the beetles all issue at approximately the same time and lay their eggs on the bark within a period of a fortnight or so, it would be quite possible to make an attempt to check the pest in localities where it is seen to be bad by scraping down the bark of the trees with a blunt instrument. This would get rid of the eggs and save the tree. I recognize that there would be difficulty in doing this, owing to the fact that the sandal usually grows in the midst of thorny scrub bushes. In the case of severe attacks, however, it would be quite feasible, and the value of the tree would justify the expense. It is therefore of great importance that the periods of emergence of the beetle and of oviposition should be ascertained. Trees infested are recognizable by the air-holes bored to the outside. Further, we have seen that a tree infested

in previous years is liable to be attacked again in a succeeding year. So it would be well to remove those in which air-holes and fresh exit-holes are present.

A study of the predaceous and parasitic insects which prey upon the larva should also prove most useful.

Cerambyx ? sp.

REFERENCE.—Stebbing, Some Assam Sál Insect Pests, *For. Bull.* no. 11 (1908).

Habitat.—Goalpara, Assam.

Tree Attacked.—Sál (*Shorea robusta*).

Description. **Larva.**—Elongate, white, smoky-black at joints of segments. Head and mouth-parts black. Prothorax swollen, prominent, hood-like, pointed anteriorly; yellowish with two transverse orange lines dorsally, one anteriorly and the other posteriorly. Segments following prothorax narrow and taper to a little behind the middle, and then increase in width to tenth, thence constricting. Three small pairs of feet on thoracic segments. Length (not full-grown), $1\frac{1}{2}$ in. (See fig. 256, 1).

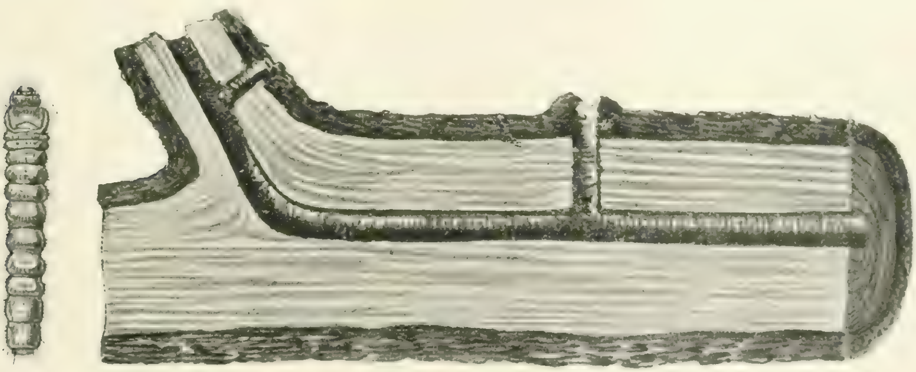


FIG. 256.—*Cerambyx ?* sp.—1, larva; 1*a*, section of stem of a sál-pole showing the larval gallery in sál-wood with two aeration galleries.

Life History. The grub bores into the centre of the branch on which the egg is laid, and tunnels down it till it reaches the main stem and then proceeds down that. The method of operation of the grub is very similar to that of the sandal-wood longicorn described above. Immature grubs were taken in sál saplings and poles in Goalpara in April and May 1906. The insect is likely to prove a pest in young sál plantations and coppice areas. The method of attack is shown in fig. 256, 1*a*.

CHAPTER XVII.

RHYNCHOPHORA.

TARSUS four-jointed on all legs, and densely pubescent. The head is prolonged into a beak which may be of considerable length. The group includes the families Anthribidae, Brenthidae, Curculionidae, Scolytidae, and Platypodidae. The last three contain a number of most destructive bark- and wood-boring pests.

Family ANTHRIBIDAE.

The beetles of this family have a strong resemblance to longicorns on the one hand and weevils on the other. The larger members of the family will perhaps mostly be found inhabiting the old primeval forests of the country, a few such having already been discovered in these localities. The beetles known are of small size when compared with the larger Cerambycidae and Curculionidae, the colour being dull black or brown, with straight, occasionally long, antennae of eleven joints ending in a club. The proboscis is short, square, and blunt, and the tarsi four-jointed.

The grubs are white, curved, and corrugated, resembling weevil grubs; but some have, it is said, three pairs of legs on the anterior segments, which are not present in the weevil grub.

Few species have yet been studied in the forests, but those known have been taken from the bast and wood of trees. Others are reported to live in seeds, whilst some members of the family frequent and breed in mushrooms. It is not possible at present to define accurately the importance of the family in the forest.

Xylinades plagiatus, Jord. (?)

Habitat.—Tharrawaddy, Lower Burma.

Tree Attacked.—Pyinkadu (*Xylia dolabriformis*). Kadin Bilin Forest, Tharrawaddy.

Description.

Beetle.—Elongate, black, mottled with yellowish markings, due to presence of depressions filled with a dense yellow pubescence. Antennae heavy, joints broaden apically, last one forming a stout club, black; legs with patches of yellow pubescence on them. Head sloped forward at an angle, tuberculate, with a shining longitudinal keel-shaped ridge medianly between eyes; vertex smooth, dull. Prothorax widest across anterior half, sides rounded anteriorly, constricted towards base, latter straight; disk convex, set with irregular transverse series of prominent shining black protuberances, becoming obsolete basally. Sides of elytra constricted behind humeral angle, thence slightly widening to near apex, thence constricted and conjointly rounded; the apical fourth covered more or less densely with yellow pubescence disclosing areas of dull black; rest of surface exhibiting longitudinal series of rather scattered elevate shining black points surrounded by dull areas, covered in places with yellow pubescence. Under-surface dull pubescent. Length, 14 mm.

FIG. 257. *Xylinades plagiatus*, Jord. (?) Tharrawaddy.

Life History. In January 1905 I cut out a specimen of this beetle from a pupal chamber in the wood at the base of the stem of a large girdled pyinkadu-tree. The outer sapwood of the bole of the tree was covered from base to top with the shallow larval galleries of a bast-feeding grub. I was unable to say whether these galleries were made entirely by the grubs of this anthribid, but one of the galleries led down into the pupal chamber in which the fully mature beetle was found.

Phloebius apicalis, Walker.

REFERENCE.—Walker. *Ann. Nat. Hist.* ser. 3, iii, p. 262 (1859).

Habitat.—Tharrawaddy, Lower Burma, Ceylon.

Tree Attacked.—Pyinkadu (*Xylia dolabriformis*). Kadin Bilin, Tharrawaddy.

Description. **Beetle.**—Elongate, rather thick, with very elongate thin antennae; the third tarsal joint large and broadly heart-shaped. Black, covered with a very short dense canary-yellow pubescence. Head narrow, caniculate medianly; rugose and clothed with yellow pubescence. Prothorax much wider than head, widest across middle, the sides truncate on either side of this point, base straight; disk convex, rather finely transversely striate and punctate. Elytra broadest at base, slightly constricted apically; apices conjointly rounded, exposing a small pygidium; finely, rather irregularly, and obscurely striate-punctate, and covered with the close yellow pubescence, densest apically. Under-surface dull, very finely punctate and pubescent. Legs long, black, with very prominent enlarged third tarsal joints. Length, 13.5 mm. (without antennae).

FIG. 258.
Phloebius apicalis, Walker. Tharrawaddy.

Life History. I took specimens of this insect from small pupal chambers in the sapwood of a large girdled pyinkadu-tree in the Kadin Bilin Forest in Tharrawaddy on 5 January 1905. The larval galleries were found to run in the bast and sapwood, the grub pupating in the latter. The beetles were mature and ready to fly.

Anthribid.

REFERENCE.—It has not proved possible to obtain the identification of this species.

Habitat.—Ataran River, Tenasserim.

Tree Attacked.—Pyinkadu (*Xylia dolabriformis*). Natchoung, Ataran River.

FIG. 259.
Anthribid.
Tenasserim.

Beetle.—Elongate, rather narrow. Black, mottled with small patches and spots of a whitish pubescence placed in tufts on thorax and elytra.

Description. Head sloping, the rostrum short and square, densely pubescent above; the vertex coarsely rugose. Prothorax widest behind, sides rounded; coarsely rugose-punctate and covered with a short close brown pubescence with short tufts here and there of a whitish pubescence. Elytra slightly wider than thorax at base, constricted apically; punctate, the punctures deep, rather far apart in longitudinal rows, the interspaces moderately shining, covered, especially laterally, with the short rather dense brown pubescence, interspersed with large patches and tufts of longish white pubescence. Pygidium dark brown. Legs black, with patches of white pubescence. Length, 10.5 mm.

Life History. I cut out a specimen of this insect from a gallery in the sapwood of a large felled pyinkadu-tree in the compound of the Natchoung bungalow. The tunnel in the wood led from an elongate broad gallery made by the larva in the bast and sapwood. The beetle was mature when it was taken from the tree in the middle of March 1905.

Anthribid.

REFERENCE.—It has not proved possible to obtain the identification of this insect.

Habitat.—South Coimbatore, Madras.

Tree Attacked.—Bamboo (*Dendrocalamus strictus*). Mount Stewart, South Coimbatore.

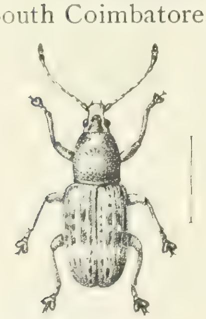


FIG. 260.
Anthribid.
South Coimbatore.

Beetle.—Resembles the last. Head with a stout moderately long rostrum, widest medianly and densely pubescent, antennae

Description. inserted in front of eyes half-way up rostrum; vertex shining, punctate. Black, the prothorax with a scattered, the elytra a dense, yellow pubescence, placed anteriorly on prothorax and in patches and tufts on elytra. Prothorax slightly widest medianly, sides curved; punctate, punctures large, confluent or mixed with transverse striae posteriorly. Elytra with apices separately rounded, the sides straight to posterior coxae, thence constricted; punctate-striate, punctures large, but almost hidden beneath the dense pubescence; the pubescence is densest laterally and apically, and consists of short dark yellow hairs and long whitish yellow ones which appear in tufts in basal part in a transverse band in apical three-fourths and in patches in apical fourth. Under-surface with a short dense pubescence. Antennae long and slender, black. Legs black, pubescent, the third tarsal joint large. Length, 11.5 mm.

Life History. A specimen of this anthribid was taken from a chamber in the wood of a *Dendrocalamus strictus* bamboo. From an examination of bamboos in the Mount Stewart forests it appeared that the eggs are laid at the junction of a branch with the main stem of the bamboo, and that the grubs feed in the wood at this spot. Many bamboos were noticed to have been infested in this manner. Only one mature beetle was, however, taken towards the end of July 1902, and no larvae were found.

CHAPTER XVIII.

RHYNCHOPHORA (*continued*)—Family BRENTHIDAE.

THESE insects resemble weevils, from which they may be distinguished by the straight antenna of nine to eleven joints instead of the angled one of the weevil. The proboscis also is straight, never bent downwards. The few forest forms studied are narrow, elongate beetles, brown, black, or reddish in colour, usually shining.

But little is known about the family. The larger and more striking forms would appear to inhabit the dense tropical or semi-tropical evergreen primeval forests of the country. A study of these forms will prove of interest scientifically, since it is highly probable that modern conservation and protection when introduced into such areas will result in the extinction of these forms of insect life.

The few species known to me have been taken beneath the bark and in the sapwood of trees, the larvae apparently living and feeding in such places. It is not impossible that a study of the habits of these larvae may show that some of them are predaceous on bark- and wood-feeding insects.

CEOCEPHALUS.

Ceocephalus reticulatus, F.

Habitat.—Dehra Dun, Siwaliks, Northern India; Duars, at the foot of the Eastern Himalaya.

Trees Attacked.—Semul (*Bombax malabaricum*): Dehra Dun, Siwaliks; Musré Katús (*Castanopsis tribuloides*): Mal Forest, Duars.

Description.

Beetle.—Very elongate, narrow, with a very long rostrum and prothorax. Dark brown, an elongate median depression on prothorax, and the elytral punctures filled with a short dense yellow pubescence. Head small, the eyes large, brown, placed at the sides; rostrum longer than prothorax, swollen in middle, where the short antennae are inserted, widened at tip, the lower half pubescent, the upper smooth, the apex shining. Prothorax widest just above base, the anterior margin almost smooth; disk flat, rather shining, punctate, with a rather wide longitudinal median depression starting from below the anterior margin. Elytra broadest basally, strongly and widely striate-punctate, the disk flat to near apex, thence constricted, the apical edges flattened into a broad edge. Under-surface black, shining, an elongate wide median depression on anterior abdominal segments strongly reticulate and punctate. Length (Eastern Duars), 26 mm. to 39 mm; (Siwaliks), 18 mm.

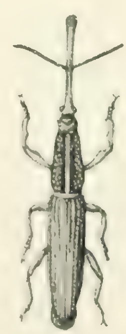


FIG. 261. *Ceocephalus reticulatus*, F. Dehra Dun; Duars.

This insect was taken in February from beneath the bark of a semul-tree in the Dehra Dun forests by Babu Sen Gupta, then a student at the Imperial Forest School.

Life History.

Specimens of the same brenthid, but of larger size, were sent from the Mal Forest in the Duars of the Tista Forest Division in Bengal by the Forest Ranger, with the report that the beetles were cut out from the bast and sapwood of *Castanopsis tribuloides*, and other "jungle trees." I had previously found this insect beneath the bark of trees in this forest and elsewhere whilst I held charge of the division in 1895–7.

Ceocephalus carus, Walk.

REFERENCE.—Walk. *Ann. Mag. Nat. Hist.* (3) iii, p. 262 (1859).

Habitat.—Dehra Dun, Siwaliks, Northern India, Ceylon.

Tree Attacked.—*Terminalia tomentosa*. Thano, Dehra Dun (B. Sen Gupta).

Beetle.—Smaller and narrower than *reticulatus*. Dark red, moderately shining. Head small, tuberculate, finely punctate; rostrum about as long as prothorax, widened above middle into a swollen node at which antennae are inserted; the apex broad, smooth. Prothorax widest in basal three-fourths; disk flat, with a longitudinal median depression running from near top to base; surface smooth, shining. Elytra elongate, narrow, constricted at apex, the apical edges flattened; disk depressed on each side of suture, with two well-marked punctate costae; the lateral portions rounded, smooth, and finely punctate. Legs long, the femora swollen anteriorly. Length, 18 mm. to 19 mm. with rostrum.

Description.

A specimen of this beetle was found by Babu Sen Gupta, a student of the Imperial Forest School, "boring the bark of a dead *Terminalia tomentosa* tree" at Thano in the Dun. The insect was taken in the beginning of December.

Eubactrus sp.

Habitat.—Jaunsar, North-West Himalaya.

Tree Attacked.—*Pinus longifolia*. Thadiar, Jaunsar (B. Sen Gupta).

Beetle.—Small, elongate, narrow. Shining red. Head small, finely punctate; rostrum with a longitudinal channel down basal portion, the antennae inserted on a swelling just below middle, the depression being continued down the node; anterior portion smooth, shining, widest at apex; antennae short. Prothorax widest medianly, anterior margin straight and edged with black, sides rounded; a broad longitudinal depression runs from anterior margin to basal one, the disk being flattened on each side; sides laterally rounded and smooth. Elytra rather strongly striate-punctate, the carinae most prominent on diskal area, the sides but slightly constricted to apex; latter uniformly rounded, with a narrow flattened edge; an obscure narrow transverse faint band of black in apical half. Legs moderately long, the femora thickened anteriorly. Length, 8 mm.

Description.

FIG. 262.
Eubactrus sp.
North-West Himalaya.

Life History. Babu B. Sen Gupta, whilst on tour with the Imperial Forest School in May 1902, found a specimen of this undetermined brenthid boring into the dead bark of a *Pinus longifolia* tree at Thadiar in the Jaunsar Himalaya. Nothing further appears to be known on the life history of the insect.

PROPHTHALMUS.

Prophthalmus tridentatus, Fabr.

REFERENCE.—F. *Syst. El.* ii, p. 554; Lund. *Skrivt. af. naturhist selskab.* v, 2, p. 91 (1802).

Habitat.—Darrang, Assam.

Tree Attacked.—*Pterospermum acerifolium.* Balipara Reserve, Darrang.

Description. **Beetle.**—Elongate, moderately thick. Dark red-brown to blackish in parts. Elytra lighter with several orange spots and patches. Head small, punctate and caniculate medianly in front; rostrum moderately long, curved, the antennae taking off from near base. Prothorax widest just above base, narrowed in front; a transverse channel above basal margin; very shining and smooth on disk. Elytra very strongly striate, the punctures small, sides straight to near apex, thence constricted; a short thickened longitudinal orange-yellow shining carina projects upwards from base on each side of suture; two irregular orange patches, one placed medianly and laterally, the other in the apical third, and a longitudinal short one near apex. Legs rather short. Length, 16.5 mm.

Pupa.—Elongate. Orange yellow, with a long dark brown rostrum pressed down against chest. Length, 17 mm.

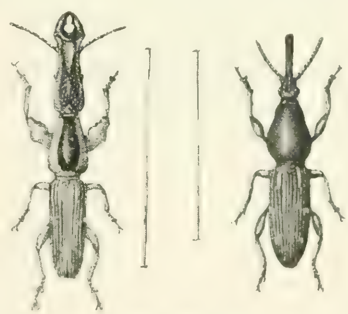


FIG. 263.
Prophthalmus tridentatus, F.
Male (left) and female.
Darrang, Assam.

Life History. From a fallen *Pterospermum acerifolium* tree, still fresh and sappy, I cut out two pupae from their pupal chambers in the sapwood. The chambers were elongate and parallel to the long axis of the tree, and about half an inch down in the sapwood. From one of these pupae I was able to rear a beetle.

The pupae were taken on 14 April 1906 in the Balipara Reserve in the Evergreen Forests belt of the Darrang Division. The beetle assumed its full coloration on 2 May following.

Zemioses sp.

REFERENCE.—Steb. *Brenthus* Ass. Sal Insects, *For. Bull.* no. 11, p. 13 (1906).

Habitat.—Assam.

Tree Attacked.—Sal (*Shorea robusta*). Kachugaon, Goalpara.

Beetle.—Elongate, narrow, crimson-red in colour, with short, stout antennae, and long legs. Elytra with three or four prominent longitudinal striae, the lateral ones less prominent. Head shining with a transverse median constriction, a small depression between insertion of antennae. Prothorax convex, very shining, with a few fine punctures. Elytra strongly striate-punctate, the sutural carinae prominent and smooth; constricted and slightly depressed apically; the punctures smaller on lateral surfaces. Legs shining, the femora thickened. Length, 5.5 mm. to 6.5 mm. Pl. lx, fig. 10, shows a dorsal view of this beetle, and fig. 10 *a* a piece of wood with a gallery in it made by the beetle.

Description.

Life History.

This beetle was cut out in some numbers from the wood of the main stem of a stag-headed green sál-tree felled on 14 May in the Kachugaon forests. The beetle appears to bore circular tunnels through the bark, and lays its eggs in these. I have not yet taken any larvae.

The discovery of this beetle in this situation is of very considerable interest, since so little is known about the life histories of the beetles of this family. Many are thought to be predaceous, and it may be that the larvae of this insect feed predaceously upon wood-boring larvae. I think, however, that it is perhaps more probable that they are true bark- and wood-borers.

CHAPTER XIX.

RHYNCHOPHORA (*continued*)—Family CURCULIONIDAE.

(*Weevils.*)

THE weevils for the most part are easily distinguished beetles owing to the head being prolonged into a beak or rostrum of varying length, upon which the elbowed and clubbed antennae are borne. The antennae often fold back into grooves placed in the sides of the rostrum. Some of the forest species have also a definite bulky shape, the elytra being very convex, and the insect reaching to over fifty millimetres in size. A large number are, however, very much smaller, some only five to six millimetres in length or thereabouts.

Beetle.

The beetles vary in coloration, dull browns and blacks predominating in the forms which tunnel into trees. Grey is common in the family, and red, pink, yellow, and green forms are also present, this bright coloration often depending on the pubescence or scales or a mealy covering which clothes the insect. The third tarsal joint is frequently heart-shaped. The small eyes are situated at the base of the rostrum, the mouth at the tip; the rostrum varies greatly in shape and length and in position, in some being projected outwards more or less in the horizontal plane; in others, such as, e.g., the cryptorhynchids, being directed downwards in the vertical plane. The antenna has the elements of the scolytid antenna in it, consisting of a basal segment, the scape, six or seven shorter segments which represent the funicle, and three or four other broader segments which form the club. The prothorax is usually well developed, and the elytra cover the body completely in most cases, and are bent down to a certain extent over the sides. The males are often readily distinguishable from the females by their smaller size, elongate front legs, and the different shape and length of the rostrum.

FIG. 264.
The Palm Weevil *Rhynchophorus ferrugineus*, Oliv. India.

Larva.

The larva of forest curculionids is usually a soft, white, curved, legless grub with a yellow or brown head, strong mandibles, and corrugated segments to the body. In some forms the body is thickest posteriorly, in others across the centre, the grub tapering at both ends; tubercles are sometimes present on the body.

The pupa is white, elongate, and narrow or squat and thick, and is usually recognizable as a curculionid pupa by the presence of the elongate soft rostrum.

Pupa.

Some of the grubs of this family build a cocoon before pupating. This cocoon is usually made of fibres taken from the plant in which the grub has been living. The cocoons vary greatly in shape, and often fit closely into a bore or hole eaten out specially for their reception at the end of or to one side of the larval gallery.

Cocoon.

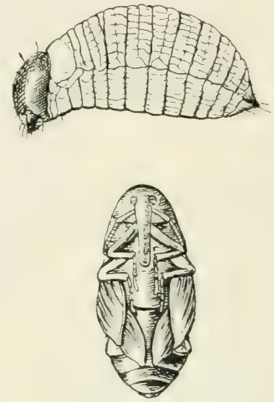


FIG. 265.
Larva and pupa of the Palm Weevil (*Rhynchophorus ferrugineus*). India.

A systematic study of the Curculionidae of the forests by Indian foresters is much needed. Not only will such a study be fruitful in yielding a large number of forms at present unknown to science, but it will enable the exact position and importance of the family and its economic place in the forest to be understood.

The weevils are a large family of beetles, containing some insects known to be pests of the first importance. It has already been definitely ascertained that one genus at least, *Cryptorhynchus*, contains Indian forest pests of the first rank. And the genus does not confine itself to the conifer or the broad-leaved tree, as is the case with other groups and genera of forest beetles. Both conifers and broad-leaved trees are infested by different species of this genus in India.

The habits of the weevils are varied, the insects of the family infesting and damaging the bark, wood, stems, shoots, leaves, flowers, fruits, and seeds of forest crops. The damage is done primarily by the grubs tunnelling in the interior of the plant, but in some groups considerable defoliation is accomplished by the insect in the mature state, either directly for feeding purposes, or indirectly, as in *Apoderus*, for the purpose of egg-laying and to provide food for the offspring. The weevils of these defoliating groups cut the leaf across on either side to the midrib, lay an egg near the apex of the leaf, and then fold and roll the leaf up into a tight elongate cylinder, which dries and forms food for the grub which hatches inside it (cf. figs. 281, 282). Others, more serious pests, oviposit in the bark of the main stems, main roots, and large branches of green trees, their grubs eating out long galleries in the green bast. This group of the family is of the greatest importance to the forester, and a knowledge of its habits is essential to the correct preparation of working plans. Some members of the already mentioned genus *Cryptorhynchus*, for instance, pass their lives in this fashion, appear to be immune

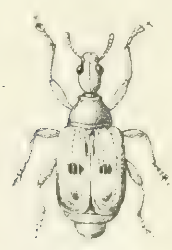


FIG. 266.
Apoderus sissu, Mshl. Changa Manga.

to extremes of heat and cold, have several generations or life-cycles in the year, and in some instances would appear to continue the succession in a particular tree until the tree has been killed. If the sustenance afforded by the tree, i.e. the green-bast layer, has all been removed just before the winter season, the mature beetles appear to hibernate till the spring before leaving the tree. If the attack on the tree is not complete the beetles apparently couple even in the late autumn and early winter, and eggs are laid. This habit seems to be common at elevations below about 3,000 ft. in mountainous regions. These bark-feeding forms pupate either in the sapwood or thick bark of the trees they infest. Other species confine their attacks to the soft succulent shoots and twigs of the trees, the grubs eating out the heart and killing the shoot. Instances of this method of attack are best seen in the case of bamboos infested by particular species of weevils. The insect usually lays its eggs near the upper part of the growing shoot of the bamboo, and not infrequently chooses for her purpose a young bamboo in its first year of growth. The grub tunnels out the heart of the growing shoot, eventually pupating near the top. This top dries and falls to the ground, the pupa remaining in it till the beetle has matured. This is a very common form of attack by species of the genus *Cyrtotrachelus* (p. 440). Another genus—and there may be more than one—girdles young seedlings and lays its eggs in the part above the girdle, the grubs feeding on the slowly decaying tissues of this portion.

Other genera, again, appear to confine their attacks to the seeds and fruits of trees. The eggs are laid either in the flower or more commonly in the young fruit, the weevil making a small hole in one side of it and inserting one or more eggs. The young grubs feed inside the growing seed or fruit, eventually partially or completely hollowing it out. The dead fruit or seed then falls to the ground, the grub or grubs either pupating inside it or tunnelling out of it into the ground and pupating there. This is the life history of probably a considerable number of the seed-eating weevils of the forests, of which species of *Alcides* and *Calandra* furnish examples.

The forester will rarely find the weevils which are reared inside the tree or in the seed on the wing in the forest. They are mostly nocturnal insects, issuing when mature at night and flying off in search of fresh trees to oviposit in or pair upon. In fact, for the forester, broadly speaking, the weevils divide themselves into two divisions: (1) The nocturnal group, containing serious pests infesting the bast of the main stem of the tree, and often killing it or infesting and destroying the seed, and thus restricting, or for one or more seasons entirely preventing, natural regeneration of the species. (2) The diurnal division, the weevils which are to be found on the wing in the forest during the daytime, feeding upon the leaves or flowers or ringing or feeding on the green shoots. These beetles are usually brighter in colour than the nocturnal ones. The group includes a large number of species belonging to such well-known genera as *Myllocerus*, *Apoderus*, *Rhynchites*, *Cyrtepistomus*, etc.

Members of both the groups have in a large number of instances one habit in common: they sham death when disturbed, and to enable the deception to be carried out to perfection the insect is able to fold up the antennae and legs flat against the sides in such a manner that they are scarcely observable. In the diurnal species this habit affords a valuable protection against enemies, as they drop from the plant in a second and are lost in the jungle-growth below. The habit is probably equally useful to the bark- and wood- and seed-feeders during the short period they spend on the wing moving from the tree in which they were reared to the fresh one they select for ovipositing.

The weevils are a very large family of beetles whose classification is a matter of considerable complexity. The Indian forms known are undergoing revision by Mr. Guy A. K. Marshall for the *Fauna of British India* series, volumes whose publication should prove of great aid to the study of the family.

Mr. Marshall has very kindly identified the Dehra Dun collections for me, describing some seven new species, dealt with below, in the *Annals and Magazine of Natural History* for February and August 1913.

Astycus.

Astycus lateralis, Fabr.

Reference.—Fabr. *Ent. Syst.* i, 2, p. 451.

Habitat. Tharrawaddy, Lower Burma. Also reported from the Shan States, Tenasserim, and Assam.

Tree Attacked.—Teak (*Tectona grandis*). Kadin Bilin Forest, Tharrawaddy.

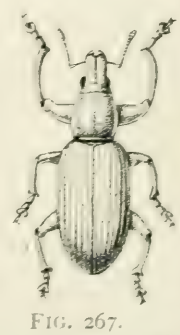


Fig. 267.
Astycus lateralis, Fabr.
Tharrawaddy.

Beetle.—Elongate, rather narrow, variable in size. Green or blue-green, golden yellow on sides, with a golden metallic iridescence; eyes black. Rostrum short, truncate; coarsely rugose, with a longitudinal narrow median line; antennae placed near upper end. Prothorax widest just behind middle, anterior and posterior margins straight, the surface having the appearance of a fine tessellated pavement. Elytra with basal outer angles oblique, sides straight to posterior coxae, thence rather obliquely constricted, depressed behind, convex; rugose and finely striate. Under-surface [illegible] coloured, rugose. Legs finely rugose. Length, 8 mm. to 14 mm.

Description.

I took two dead specimens of this weevil clinging to the stems of young teak saplings in a 1902 tounggya plantation in the Kadin Bilin Forest of the Tharrawaddy Division. It is possible that they had died in this position after laying eggs on the bark of the trees.

Life History.

ATMETONYCHUS.

Atmetonychus peregrinus, Oliv.

REFERENCE.—Oliv. *Ent.* v. 83. p. 324. t. 24. f. 349 ; Stebbing, *Hypomeces* sp. *Ind. Mus. Notes*, vi. 1. 68 (1903).

Habitat.—Katha, Burma. Also reported from Bengal.

Trees Attacked.—Mango (*Mangifera indica*). Peach (*Prunus persica*). Plum (*Prunus communis*). Katha, Upper Burma (J. Messer).

Description.

Beetle.—A largish stout black weevil. Proboscis broad, with a longitudinal dorsal channel and scattered white hairs anteriorly ; eyes prominent, black, placed rather far back on either side ; prothorax triangular, truncate, twice as wide behind as in front, corrugate, with a longitudinal median dorsal channel anteriorly. Dorsally the prothorax is flattened, this flattening continuing on to the elytra basally. Latter with basal margin crescent-shaped, constricted apically, striate-punctate. Legs black, tarsi yellowish brown. Under-surface black. ♀ larger than ♂. Length, 14 mm. to 16 mm.

Life History.

Specimens of this weevil were first sent to me by the late Mr. J. Messer, of the Indian Forest Service, in April 1902, who reported that the weevils were destructive to fruit-trees and ornamental trees in Katha in Upper Burma. Mr. Messer wrote : "The beetle is particularly destructive in Katha this year, though I have observed it for years past. It attacks fruit-trees, especially peach, plum, and mango (most of all), and is not averse to certain ornamental shrubs in the gardens here. It eats the leaves, leaving only the midrib, and devours the flowering shoots wholesale, leaving only the bare stems. The damage seems to be done only by the imagoes, and I have seen nothing yet of larvae or pupae." In reply to a request for further information Mr. Messer wrote in March of the following year that the insect was just commencing to appear numerously again upon the fruit-trees in his garden.

DEREODUS.

Dereodus pollinosus, Redt.

REFERENCE.—Redt. *Hügel, Kaschm.* [illegible]

Habitat.—Jubal, North-West Himalaya. Also reported from the Sulieman Range.

Tree Attacked.—Ber (*Zizyphus jujuba*). Piuntra, Jubal State.

Fig. 268. *Dereodus pollinosus*, Redt. North-West Himalaya.

Description.

Beetle.—Elongate, body rather thick : ♂ smaller than ♀. Mottled-greyish or black in colour, the greyish colouring on living beetles due to a purulescence. Head truncate in front, antennae placed near upper end, a longitudinal median channel down front bifurcating into several offshoots near upper end ; sparsely punctate. Prothorax widest behind, anterior margin straight, depressed on disk, corrugate and finely punctate. Scutellum small.

Elytra wider than thorax, basal outer angles rounded, sides straight to posterior coxae, thence sharply constricted to apex ; coarsely rugose-punctate, the rugosities appearing as transverse ridges laterally. Under-surface black, covered with the greyish purulescence ; rugose. Legs and antennae black. Length, 12 mm. to 17 mm.

Life History. Towards the end of May 1901 I found this large weevil engaged in seriously defoliating the ber in the Shalu Valley near Piuntra in the North-West Himalaya. In many cases the small thorny trees were loaded with weevils and were quite leafless under the attack. The weevil was coupling.

Episomus.

Episomus lacerta, Fabr.

Reference.—Fabr. *Spec. Ins.* i, p. 190.

Habitat.—South Coimbatore, Madras.

Trees Attacked.—*Dalbergia paniculata* ; Teak (*Tectona grandis*). Mount Stuart, Anamalai Hills, South Coimbatore.

Beetle.—♂ A large, heavily built weevil ; mottled grey-brown all over, including legs and antennae ; a thick blunt proboscis, the antennae inserted near the top ; eyes small, black.

Description. Prothorax rather small. Elytra large, very convex on top, depressed behind and constricting sharply to apex. Head and prothorax corrugated ; elytra deeply channelled and punctate, the sides bent right down on to under-surface of body. Legs thick, stout, with broad tarsal pads. Under-surface greyish-white.

♀ Resembles male, but of a uniform greyish yellow in colour. Of the same size as the ♂, in some cases a trifle larger.

Life History. I took specimens of this weevil defoliating *Dalbergia paniculata* trees in the Mount Stuart forests in South Coimbatore towards the end of July 1902. I also found the weevils on teak-trees, but do not know whether they also feed on the leaves of this tree. The insects were engaged in coupling.

Myllocerus.

An important genus of defoliating weevils.

Myllocerus viridanus, Fabr.

Reference.—Fabr. *Syst. Ent.* p. 155.

Habitat.—Coimbatore, Madras.

Tree Attacked.—Teak (*Tectona grandis*). Mount Stuart, Anamalai Hills; Walayan Forest, Coimbatore.

Beetle.—Elongate, small, usually a dead white in colour, both above and below, or a very pale yellow-green. Antennae long, black. Legs long, black ; tarsal joints with broad pads.

Description. Eyes black, proboscis short, the antennae inserted near the end some distance in front of the eyes. The coloration is due to a white purulescence or bloom of a powdery nature, which entirely covers the insect. The under-surface often shows black in patches where the "bloom" has got rubbed off. The ♂ is smaller than the ♀. Length, ♀ 5 mm. ; ♂ 4 mm.

Life History.

This small, white, striking-looking weevil was by far the commonest insect present in the Mount Stuart forests in the Anamalai Hills towards the end of July 1902, and was also taken in considerable numbers in the Walayan Forest near Coimbatore at the commencement of August 1902. The mature insect feeds on the teak leaves, and when it is present in the numbers observable in 1902 the defoliation committed is heavy. In eating the leaf the beetle leaves untouched the main veins, and thus, to some extent, its attack resembles that of the caterpillar of the moth *Hyblæa puera*. It is distinguishable, however, owing to the fact that the weevil does not eat the parenchyma of the leaf clean up to the vein, but leaves small patches of unconsumed tissue here and there, as shown in the drawing made in the forest from a defoliated leaf. Short pieces of the side veins are also left unconsumed by the beetle. The edges of places eaten out of the leaf are ragged and not clean-cut, as is usually the case with parts of leaves eaten by caterpillars. Numbers of leaves on the trees were found in the condition shown in the drawing.

Fig. 269.
Teak-leaf defoliated by *Myllocerus viridanus*, Fabr. Coimbatore, Madras. E. P. S.

Relations to the Forest.

The defoliation committed by this little weevil is of a serious nature, owing to the fact that the teak-trees are subject both before and after the time of appearance of the insect to the attacks of the two defoliating caterpillars, *Hyblæa puera* and *Pyrausta machæralis*.

The Walayan Forest is said to be infested by both these caterpillars, often being heavily defoliated in the spring, and again in September. Consequently the

defoliation committed by these three insects in years of bad infestation keeps the trees leafless for the greater part of the year, retarding the growth of young plants and poles, and reducing the increment put on by older trees. The area, I was informed, is managed under a working plan for the supply of sleepers to the railway running through the forest to Calicut, and of firewood and small material to Coimbatore. The growth of the trees is poor for the most part, and the natural regeneration is scanty.

Efforts should be made to deal with the defoliating pests.

Myllocerus lineatocollis, Boh.

(*The Semul Defoliator.*)

Habitat.—Goalpara, Assam. Also reported from the Nilgiris (Hampson).

Tree Attacked.—Semul (*Bombax malabaricum*). Goalpara.

Beetle.—Very small and slender. Bright green or golden green with a golden iridescence; antennae and legs orange or yellowish brown. Rostrum moderately long, truncate at top, with antennae inserted at tip, the black eyes placed behind the middle of rostrum; a slight median longitudinal impressed line on upper half, the rest of surface finely rugose. Prothorax slightly wider in front than behind, anterior margin curved outwards, sides constricted slightly medianly; disk finely rugose, with a median longitudinal dark brown stripe starting from anterior margin and not quite reaching the posterior one. Elytra finely striate-punctate, base straight, sides straight to posterior coxae, thence constricted to apices. Under-surface golden green, finely punctate. Length, 4.5 mm. to 5.5 mm.

Description.

FIG. 270. *Myllocerus lineatocollis*, Boh. The semul defoliator. Assam.

Life History.

During a period of seven years spent in charge of the Goalpara Forest Division, Mr. W. F. Perrée noticed that the semul-trees were often heavily defoliated during the hot weather (May and June). His observations tended to show that the trees suffered either partial or total defoliation during the year. He considered that to some extent at least the poor growth of the semul in parts was attributable to this little beetle defoliator, which in some years appeared in incredible numbers.

In May 1906 I had an opportunity of studying this attack with Mr. Perrée at Kachugaon on the Sunkos River and elsewhere in Goalpara. During the second week of May the beetles were found abundantly pairing on the trees, the female being larger than the male.

The beetle's attack is confined to the foliage. In defoliating the leaf the *Myllocerus* either attacks it at the edges or eats out holes from the centre of the leaflets. The major portion of the leaflet is often consumed, the remainder withering and dropping to the ground.

It is of importance that the life history of the insect should be carefully studied and the habits of the larva ascertained, since the semul has a considerable commercial utility in Assam. When the insect oviposits and where the grubs feed are points requiring elucidation before we can say how the attack is to be combated.

Myllocerus carinirostris, Marshall, sp. nov.

REFERENCE.—*Ann. Mag. Nat. Hist.* Aug. 1913, p. 184.

Habitat.—Tharrawaddy, Lower Burma.

Tree Attacked.—Teak (*Tectona grandis*). Konbilin Forest, Tharrawaddy.

Description.

Beetle.—Colour black or chestnut-brown, with brown and green scaling; the sides and underparts pale metallic green; the prothorax dark brown above, with two narrow green stripes; the elytra indistinctly striped, the intervals 1, 3, and 5 being brown, the suture and alternate intervals rather paler and more or less irrorated with green scales, especially at the base of 2. Head not continuous with the rostrum in a single plane, but with the elevated base of latter continued on to the forehead, being broadly truncate at its base, and terminating abruptly so as to form a transverse furrow between the eyes; the latter widely separated and almost circular. Rostrum about as long as broad, longer than the head, somewhat dilated at the apex, the apical margin deeply and acutely incised, the raised dorsal area depressed in the middle without any central carina, the lateral carinae elevated far above the upper margin of the eyes and forming an angular prominence above the insertion of the antennae. Antennae stout, the scape reaching the middle of the prothorax, with conspicuous curved setae, and brown and green scaling, the funicle with the basal joints elongate, 2 longer than 1, 3 slightly longer than 4, 2 and 6 with whitish scaling. Prothorax sub-cylindrical, the sides almost straight, the apex scarcely narrower than base, the basal margin deeply bisinuate, the apical margin roundly prominent; when the scaling is intact the upper surface is closely covered with small punctures, each containing a short scale-like seta, and there is a shallow transverse impression behind the middle. Elytra comparatively broad, with the shoulders rather prominent, the sides slightly sinuate behind the shoulders and rounded posteriorly, being broadest behind the middle, the apices broadly truncate, the longitudinal curvature very convex, the striae deep and distinctly punctate, the intervals convex and closely set with short, sub-erect, broad, scale-like setae. Legs red-brown, with green and grey scaling, all the femora with a small tooth, the tibiae simple. Length, $5\frac{1}{2}$ mm. to $6\frac{1}{2}$ mm. Breadth, $2\frac{3}{8}$ mm. to 3 mm.

FIG. 271. *Myllocerus carinirostris*, Mshl., sp. nov. Tharrawaddy.

In specimens which appear to be females of this species, the rostral plate is rather narrower, and its sides are distinctly sinuate and not strongly carinate. The presence of this rostral plate will distinguish this *Myllocerus* from every other described species. (Marshall *descr.*)

I took a specimen of this weevil on a leaf of a teak seedling in a 1904 tounggya plantation in the Kadin Bilin forests towards the end of January 1905. I know nothing further about the insect.

Myllocerus 11-pustulatus, Faust., var. maculosus, Desbr.

REFERENCE.—*Myllocerus* sp. Stebbing, *Depart. Notes*, i, 31 (1902)

Habitat.—Sutlej Valley, Kulu and Bashahr States, 2,300 ft. to 3,500 ft.

Tree Attacked.—Sissu (*Dalbergia sissoo*). Sutlej Valley.

Beetle.—The beetle is a brightish grey-pink in colour, about half an inch in length. Dorsal surface grey-pink with black hieroglyphic markings on the elytra, which are slightly channelled and pitted. Under-surface grey. Antennae and legs grey.

Life History.

This beetle is found on the wing in the middle of June, when it defoliates the sissu, feeding on the leaves of the tree. It was not noticed pairing, and I was unable to form an opinion as to whether it had done so or not. The specimens found seemed to be chiefly intent on feeding.

The insect was taken in company with *Apoderus sissu*, Mshl., which was also engaged in defoliating the trees.

Relations to the Forest.

This beetle feeds on the leaves of the sissu-tree. It was not very abundant at the time it was observed, but the damage to the leaves was appreciable. It appears to prefer the older leaves, as it was on them that it was generally to be found; but this may have been attributable to the fact that most of the new ones had already disappeared under the attacks of the *Apoderus* leaf-rolling beetle (p. 418). The beetles eat into the leaf, gnawing out portions, and beginning from the outside edge. The portions eaten out are either circular or irregular in shape, and sometimes the midrib is reached, but this was rarely touched by the insect. The leaf was more often eaten irregularly away on both sides of the midrib, leaving the latter intact.

As this beetle affects the old leaves as well as probably the new, it is capable, when swarming in numbers, of doing serious defoliating injury to the trees.

Myllocerus transmarinus, Hbst. ?

REFERENCE.—Hbst. *Käf.* vi, p. 213, t. 75, f. 1.

Habitat.—Sutlej Valley, Kulu and Bashahr States, 2,300 ft. to 3,500 ft.

Tree Attacked.—Sissu (*Dalbergia sissoo*). Sutlej Valley.

Beetle.—Small, elongate, with long, slender legs. Grey to greyish brown. Antennae long. Head and thorax small. Elytra broader than thorax, constricted apically; striate-punctate. Length, 7 mm.

Life History.

This weevil was taken in company with *Myllocerus 11-pustulatus* var. *maculosus* and *Apoderus sissu* on sissu-trees in the Sutlej Valley in June 1901. The insect did not appear to be present in any numbers. Those present were eating out small holes in the old leaves of the tree. I did not observe the species to be pairing.

FIG. 272. *Myllocerus transmarinus*, Hbst. ? Sutlej Valley.

Myllocerus catechu, Marshall, sp. nov.

REFERENCES.—Marshall, *Ann. Mag. Nat. Hist.* Aug. (p. 185) 1913; Stebbing, *Depart. Notes*, i, 185 (1903).

Habitat.—Poona, Bombay Presidency.

Tree Attacked.—*Acacia catechu.* Bhamburda Reserve, Poona.

FIG. 273.
Myllocerus catechu, Mshl., sp.nov. Poona. (Drawn from type).

Description.

Beetle.—Colour black, with uniform pale metallic-green scaling, the prothorax with a lateral fuscous stripe on each side. Head almost plane, the eyes lateral and rather prominent, the forehead much broader than the space between the scrobes. Rostrum a little longer than head, shorter than its basal width, the sides narrowed from the base to beyond the middle and dilated at the apex, the apical emargination comparatively shallow and forming a right angle, shallowly impressed above, and with a fine central carina which ascends the forehead, the lateral carinae obsolete. Antennae ferruginous, the funicle with joint 1 evidently longer and thicker than 2, the remaining joints sub-equal. Prothorax about as long as broad, the sides slightly rounded, broadest at the middle, very shallowly constricted and transversely impressed near the apex, the basal margin sub-truncate and not broader than the apex, the sculpturing entirely concealed by the scaling. Elytra shallowly emarginate at base, about twice as broad as the prothorax at the shoulders, the sides parallel, distinctly punctate-striate, the intervals slightly convex, the setae very minute and depressed, only visible under a high magnification. Legs flavescent, the femora with green scaling and each with a minute tooth. Length, $2\frac{1}{8}$ mm. to $2\frac{1}{2}$ mm. Breadth, $\frac{7}{8}$ mm. to 1 mm. (Marshall *descr.*)

Life History.

This minute bright metallic-green *Myllocerus*, which has proved a new species, was found in company with *Platytrachelus juvencus*, described on page 404, feeding upon the leaves of the *Acacia catechu*, in the Bhamburda Reserve, near Poona. The insect was somewhat plentiful, but owing to its small size, less than one-eighth of an inch in length, the damage done by it was inappreciable. This weevil was pairing at the time of capture.

Myllocerus discolor, Boh., var. **variegatus**, Boh.

Habitat.—South Coimbatore, Madras.

Trees Attacked.—*Acacia intsia*, *Dalbergia paniculata*, Teak (*Tectona grandis*). Mount Stuart, South Coimbatore.

Description.

Beetle.—A fair-sized weevil, with a very mobile prothorax and convex elytra. Greyish blue, with patches of orange-brown and mottled black down centre of dorsal surface. Undersurface yellowish; legs french grey, the tarsal pads orange. The mouth-parts and antennae are blackish grey, the eyes black, prominent, and placed at back of the head, the antennae being well forward of them. The proboscis short, square, blackish on top. Elytra with well-marked striae. Legs stout. The ♂ is smaller than the ♀.

Towards the end of July 1902 I found this weevil defoliating the leaves of the thorny climber *Acacia intsia* in the forest round Mount Stuart in South Coimbatore. The weevil was very numerous, and was pairing.

I took it a few days later defoliating *Dalbergia paniculata*, and also found the beetle on teak leaves, though I am unable to say whether it defoliates this tree to any great extent.

The following notes were recorded on the process of coupling: The male is smaller than the female. The former gets on to the back of latter in a quick rush, the insect being an active one. The ♂ then protrudes from the extremity of the anal segment a shining brown chitinous horny sheath, which is bent downwards, scimitar-shaped. The ♀ then tips her body upwards into a hollow cavity in the convex elytra, a considerable space existing between the inner surface of the apical portion of the elytra and the abdomen. The end of the body is bent up into this, as if worked on a pivot near the basal segment, at an angle of 60°. This movement causes an opening to occur just below the posterior coxae (as in diagram), exposing a white inner portion of the abdomen, which is wet and glistening, as if oiled. When the body is in this position, the ♂ is apparently able to insert the penis, and this being accomplished, the body of the ♀ gradually resumes its normal position, the ♂ being then firmly attached to the ♀, about one-eighth of the brown hard shining sheath of the penis being visible.

FIG. 274.
Myllocerus discolor, Boh., var. *variegatus*, Boh. Poona.
Under-surface of ♀.
Abdomen of ♀ tipped up into elytral shell to allow ♂ to insert the penis.

PLATYTRACHELUS.

Platytrachelus juvencus, Fst.

REFERENCE.—*Myllocerus acaciae*, Stebbing, *Depart. Notes*, i, 184 (1903).

Habitat.—Poona, Bombay Presidency.

Tree Attacked.—*Acacia catechu*. Bhamburda Reserve, Poona.

Description.

Beetle.—A greyish, oblong weevil, clothed above and below with short, fine, golden yellow hairs. Rostrum not quite as long as broad, thick, and slightly enlarged at its tip. Scrobes (the grooves on the proboscis) deep, and easily seen from above and in front. Antennae placed anteriorly on proboscis near its tip, long, and clothed with short yellow hairs. Scape of antenna thickens anteriorly; funiculus with first two joints long and equal, third to seventh joints short; club oval-oblong and jointed. Eyes large. Prothorax broader behind than in front; scutellum small. Elytra almost flat in front, convex behind, deflexed to a point at their tips; are set with parallel longitudinal rows of fine punctures. Femora thickened; third joint of tarsus bilobed,

FIG. 275.
Side and dorsal view of *Platytrachelus juvencus*, Fst. Poona.

and all joints set with a fine pubescence. Second abdominal ventral segment wider than the succeeding ones, and separated from the first by a suture, which is arched in the middle. Length, 6 mm. to 7 mm. Insect winged and flies well.

Life History.

This weevil was found feeding upon the leaves of and defoliating *Acacia catechu* near Poona at the beginning of August 1901. The insect apparently only attacks the young green leaflets, which are half unfolded at this period. The beetle did not appear to be pairing, and consequently the attack had possibly only just commenced. At the time of my inspection the damage done was but small.

In June 1909 specimens of this insect were forwarded to me at Dehra Dun from the District Forest Officer, Nellore, Madras, with the information that the weevil had been defoliating *Acacia auricula* that month in the district. The beetles were found in one of the casuarina plantations of the coast range of the division.

Relations to the Forest.

As I have described, this *Myllocerus* in its adult stage does a certain amount of defoliation. Further than this, nothing appears to be known about the weevil. When and where it lays its eggs, where the larva lives, on what it feeds, and the time spent in the larval stage, have yet to be observed. Also the number of generations in the year, and how the cold weather is passed.

Cyrtepistomus, gen. nov.

Reference.—Marshall, *Ann. Mag. Nat. Hist.* Aug. (p. 186) 1913.

The following new species is placed by Marshall in this new genus, which he states to be closely allied to *Cyphicerus*, Schh. The type of the genus is *Phyllobius jucundus*, Redt., and in addition to the type Marshall refers the following described species to this genus:—*Cyphicerus deprecabilis*, Fst.; *Corigetus gracilicornis*, Fst.; *Corigetus necopinus*, Fst.; and *Corigetus testatus*, Fst. This genus is so far known to occur in India, Burma, and China.

Cyrtepistomus pannosus, Marshall, sp. nov.

References.—Marshall, *Ann. Mag. Nat. Hist.* Aug. (p. 187) 1913; *Cyphicerus* sp. Stebbing, *Depart. Notes*, i, 186 (1903).

Habitat.—Berar and Central Provinces.

Tree Attacked.—Teak (*Tectona grandis*). Melghat Forest, Berar; Damoh, Jubbulpore, Central Provinces.

Description.

Beetle.—♀ General colour brown, with blackish head and thorax. Insect covered more or less with short stiff hairs. Head with the eyes lateral and almost flat, forehead very broad with a deep short central stria. Rostrum about as long as its basal width, narrowed from base to beyond middle, thence dilated; the two carinae flanking the dorsal area slightly diverging behind and with a longitudinal furrow adjoining each externally, the dorsal area plane and with a central carina lying in a furrow. Antennae inserted near top; scrobes short and deep. The

FIG. 276.—*Cyrtepistomus pannosus*, Mshl., sp. nov. Berar; Damoh.

antennae are not inserted right at top of rostrum in ♀, but a little way down it; are set with hair; scape thick, thickening anteriorly, slightly arched; funiculus with joints 1 and 2 sub-equal, third to seventh short, and the club oval-oblong and pointed at its extremity and jointed. Eyes large, only slightly convex, oval-oblong, oblique. Prothorax rather narrow, straight in front, transverse, the sides gently rounded, base truncate; coarsely punctate, with a rounded fovea on each side behind the middle. Elytra oblong-oval, wider than prothorax, widening posteriorly, and deflexed at their apices, which meet in a point; brown in colour, with a dull white transverse band in their posterior third; the striae strongly punctate. Legs moderately long, thighs thickened and ending in a little spine beneath; tarsus very hairy beneath, third joint much broader than first and second. Body oblong. ♂ more yellow in colour, without the white transverse patch on elytra, and with the golden short stiff hairs much thicker on elytra. Antennae inserted at top of rostrum. Length, ♂ 4.7 mm.; ♀ 5.9 mm. The figure shows a dorsal and side view of this insect.

Life History.

This insect appears on the wing in Berar in July, probably generally about the time the monsoon bursts. It feeds upon the leaves of the teak-tree. Either the life of the beetle is a somewhat lengthy one, or the eggs develop at irregular periods, since a month later the weevils were found common in the Damoh forests in the Central Provinces in 1901.

In Berar the beetles were noticed pairing on 26 July, the insects being very numerous on the teak-trees, both young and old being infested.

In the middle of August the weevils were found in a similar condition in the Damoh forests. On the 20th of the month I noted the beetle as equally numerous in the Jubbulpore Division between Jubbulpore and Luckneedown. Here, as in the portions of Damoh visited, the beetle was far more numerous during this month than either of the teak-leaf defoliators *Hyblæa puera* or *Pyrausta machæralis*, which were present with it on the trees.

In Berar (in the Melghat Forest) the weevil had an additional companion in the larva of the hawk moth *Pseudosphinx discistriga*, and was in parts very much more abundant than the latter, although it was not noted as ascending quite so high into the hills as the sphinx. In this locality both the sphinx and the weevil were more plentiful than the *Hyblæa* and *Pyrausta*. Its method of defoliation is as equally distinct from that of the hawk moth as from that of the *Hyblæa* and *Pyrausta*. The weevil attacks the leaf in two ways: either by eating out patches from somewhere within the leaf, avoiding the edges, so that the leaf becomes full of irregular-shaped holes, the larger veins being always left untouched, or it eats out irregular portions from the edges, the latter having thus a ragged and frayed appearance. In both cases the edge left by this beetle always has this frayed and ragged appearance, owing presumably to the very small portions of leaf tissue it is able to take out at a time in the case of so thick a leaf as the teak leaf. The patches eaten out by this weevil can thus be easily distinguished from those

of a caterpillar attack, since the latter's bite when it goes through the leaf is always a clean cut : a frayed edge is never left. So marked is this jagged appearance of the leaves that it caught my eye and told me of the presence of the beetle as I was riding along a road in Damoh bordered with teak-trees before I had been into a forest in that district.

Neither the eggs nor the larvae of this pest have yet been found.

Relations to the Forest.

This weevil was plentiful in 1901 at the lower elevations in the Melghat teak forests lying between Ellichpur and Chikalda; in the Damoh Division between Damoh and Singrampur; between the latter place and Jubbulpore; and between Jubbulpore and Luckneedown on the Jubbulpore-Nagpur road.

While the insect undoubtedly does a certain amount of defoliation on the teak in years when it is plentiful, attacking the leaves of both young and old trees, present observation does not show it to be anything like as bad a pest as its three lepidopterous companions, and it appears doubtful whether it would ever be capable of entirely denuding a teak forest of its leaves. It must, however, be considered an enemy of the tree, and it is important that the rest of its life history should be worked out, especially the point as to where its larva lives and on what it feeds.

Protection and Remedies.

In nurseries, spraying young plants with one of the spraying solutions would have the effect of killing off the beetle. This should be done as soon as the pest makes its appearance, and repeated at intervals through July and August. The earlier the beetles are attacked, the less chance is there of their reaching the pairing stage and laying eggs.

AMBLYRRHINUS.

Amblyrrhinus subrecticollis, Marshall, sp. nov.

REFERENCE.—Marshall, *Ann. Mag. Nat. Hist.* Aug. p. 187) 1913.

Habitat.—Dehra Dun, Siwaliks.

Tree Attacked.—*Mallotus philippinensis.* Karwapani, Dehra Dun (A. M. Littlewood).

Description.

Beetle.—Black, with dense grey scaling; the prothorax with a brown stripe on each side and a narrow brown central line; elytra variegated with brown dorsally, and with a more distinct angulated brown marking behind the middle, followed by a broad, pale, oblique band. Head small, vertex densely pubescent, rostrum about as broad as long, almost parallel-sided and directed downwards, the dorsal area without any distinct anterior impression; scrobes short, oblique, black; the antennae inserted near upper end; the scape slightly longer than rest of antennae, thickest at upper end, club small. Prothorax about as long as wide, broadest behind, sides rounded, anterior margin straight; the upper surface with the sculpturing hidden by the scaling, and set with very short, sub-erect setae. Scutellum small. Elytra constricted behind humeral angles,

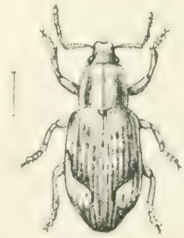


FIG. 277.
Amblyrrhinus subrecticollis, Mshl., sp. nov.
Dehra Dun.

thence widened to apical fourth, and constricted sharply to apex, which is rounded; finely striate and punctate, the punctures hidden by the scaling, the intervals convex and with rows of erect scale-like setae. Under-surface covered with a dense silvery-grey pubescence. Legs with long femora thickened anteriorly, pubescent. Length, 5 mm.; breadth, 2¼ mm.

Life History. Student A. M. Littlewood, whilst at the Imperial Forest School at Dehra Dun, took specimens of this weevil and some grubs from galleries and tunnels in the rotting bark of living *Mallotus philippinensis* trees at Karwapani in the Dun. The insects were taken towards the end of February 1902.

Brachyxystus.

Brachyxystus subsignatus, Fst.

Habitat.—North-West Himalaya. Also reported from Darjeeling, East Himalaya (C. G. Rogers).

Trees Attacked.—Silver Fir (*Abies webbiana*); Spruce (*Picea morinda*); Deodar (*Cedrus deodara*). Jaunsar, Tehri Garhwal, Simla, Bashahr, Chamba.

Beetle.—Very small. Chestnut-brown, darker on head than thorax, the upper surface covered with a short rather dense greyish pubescence. Head large, rostrum short, bent

Description. vertically downwards with the antennae near the upper end. Prothorax slightly broader than head, rather flat, sides rounded, disk finely punctate. Elytra strongly striate-punctate, base straight, sides constricted behind humeral angles, thence inclining slightly outwards to upper fourth, whence constricted, the apices conjointly rounded. Under-surface black, punctate. Length, 4.5 mm. to 5.5 mm. Plate xxviii shows the male and female beetles.

Life History. So far as present investigations have been carried, this little weevil appears to be the commonest defoliating insect of the silver fir, the young spring needles and new shoots suffering severely under its attacks. The insect is plentiful throughout the silver-fir forests of the North-West Himalaya, and in my experience appears in numbers yearly. I first took the beetle on 1 June 1901 in the forest between Baghi and Kotgarh in the Simla Division. The beetles were pairing at the time. During that year for the first three weeks of June the beetles were in millions on the silver fir, both in the Simla district and the Bashahr State beyond. By the beginning of July they had disappeared from the forest. The following year I found the weevil again, as early as 24 May, this time in the silver-fir forests between Deoban and Bodyar in Jaunsar. The beetles were pairing and were in large numbers. The weevils were taken plentifully up to the third week of June, and more rarely till the end of the month, by which time the last had disappeared from the forest. Throughout Jaunsar and in the parts of Tehri Garhwal visited that year the attacks of the beetles were very visible on the trees. In 1906 the beetle was noticed to be abundant on silver-fir trees round Simla, and again in 1909 in the forests in Chamba State.

The effect of the attack of this weevil on the tree is to cause the new shoots of the year and their needles to wither up, turn yellow or bright

. E. Stebbing pinx.

Brachyrrystes subsignata, Fst. Male and female beetles, and branches of deodar (top), spruce, and silver fir (bottom one), showing the weevil's method of attack. North-West Himalayas.

Young Silver Fir *in situ* in the forest, showing the whole of the new shoots of the year killed by the weevil *Brachyxystus subsignatus*, Fst.—The photograph was taken by Mr. J. H. Lace, C.I.E., in the Baghi Forest, Simla Division, at the end of June.

orange, die, and drop off. Once the method of operation of the beetle has been clearly understood it is the easiest thing possible to detect. From an examination of large numbers of attacked trees in the forest, and by watching the insect feed upon new silver-fir shoots in captivity, it appears that the weevils do not actually feed upon the needles to any great extent. Their chief food consists of the green epidermis of the new shoot of the year. To get at this they bite off or gnaw down the new spring needles, so as to remove them and permit their reaching the epidermis of the shoot. This latter they either gnaw off in elongate strips or eat it away in patches right down to the point where last year's shoot commences. One or two beetles may usually be found attacking a green shoot, save when the insect is very abundant, when three, four, or more will be found on it, and the shoot is then stripped of all green substance right down to the woody core in the centre. In such cases the whole of the new shoot and needles of the year are removed in the operations, leaving the top of the old shoot scarred and bare. Usually, however, the epidermis is only removed in strips and patches, and a proportion of the new spring needles remain on the shoot, the latter and the needles either turning a bright orange (most characteristic of the attack) or a pale yellow, and finally grey. The coloured plate, pl. xxviii, shows the method of attack of this weevil. Young silver-fir saplings and poles with the whole of the branches terminating with dead orange, yellow, or grey new shoots of the year are a common sight in the Western Himalaya. One such is depicted in the beautiful photograph shown in pl. xxix, which was taken by Mr. J. H. Lace, C.I.E., Chief Conservator of Forests. When the beetle is less abundant in an area it is usually the upper part of the new shoot which is attacked, the result being that the upper half only of the new shoot withers. The loss of the whole attacked shoot is, however, the commonest result.

Relations to the Forest.

In spite of the abundance of the weevil throughout the greater part of June, I have not as yet been able to discover where the eggs are laid nor where the grubs feed. A careful examination of the result of the attacks of this weevil in the silver-fir forests, carried out over a series of years, has led me to the conclusion that the effect is most serious in the case of young saplings and poles, the foliage being thinned out year after year and becoming very straggly, a result which is considerably helped by the presence of the *Chermes himalayensis* aphid. Numbers of young silver firs will be found, during a bad infestation of the insect, to have lost their new shoots, including the leaders, the trees very often presenting the appearance of having been scorched by a fire passing over them.

Trees of all ages are attacked by the weevil, from the seedling stage to old trees, and after severe attacks the trees assume their winter aspect in July.

The species principally attacked is the silver fir, but the beetles also infest, to a certain and much smaller extent, the deodar and spruce, as shown in the coloured plate.

Larinus.

Larinus ? sp.

(The Palás-tree Gall Weevil.)

Habitat.—Central Provinces.

Tree Attacked.—Palás (*Butea frondosa*). Damoh Forests, Jubbulpore, Seoni, Central Provinces.

Beetle.—I have not seen this beetle.

Larva.—White, curved, corrugated, and legless, with a smallish brown head. The grubs taken were 7 mm. in length.

Gall.—Elongate, thick, having the shape of a "Smyrna fig"; brownish or yellowish green; 1 in. in length by ½ in. or more across greatest width (fig. 278).

Life History.

In the rains of 1901 (August), during a tour in the Central Provinces, I noticed a curious gall on the branches of the palás-trees which in shape is exactly like a Smyrna fig (cf. fig. 278). The gall is usually, if not invariably, borne on the leaf-bearing branches and twigs, and is obviously a stem-gall. Occasionally it is almost sessile on the branch, with the leaf petioles growing out of the top; or it is sessile with the twig growing out of the top and terminated at varying lengths by the three leaf-bearing petioles; or, finally, the gall occurs some way up the twig, and is borne on a stalk, so to speak, the three petioles bearing the leaves growing out of the top of the gall. The outer surface of the gall bears longitudinal ridges down it. The gall is so characteristic, and occasionally so common—it was so in 1901—that it is easily recognizable.

I observed this curious growth only on small trees, saplings and small poles. The local people informed me that it was restricted to young growth and saplings, and did not occur on old trees. I have been unable to verify this statement, however.

A longitudinal section of the gall shows that it is traversed inside from a point near the top to the bottom by a longitudinal chamber having a circular section in which the grub of this weevil lives, the walls of the gall being of considerable thickness. The grub in its feeding operations sets up an irritation in the cells of the twig which causes the curious outgrowth.

The weevil evidently lays the egg on the stem or twig either on the bark or in an incision. The grub on hatching tunnels into the soft-wood structure and commences feeding in the centre, the walls of the twig swelling up.

The grubs feed during the monsoon months, the gall being formed at this period. I have no data as to when the beetles appear or when the eggs are laid.

The gall is soft and greenish-brown in appearance whilst growing in size. After the weevil has left it it turns dark brown, dries, and becomes hard and woody. The portion of the twig with the leaves above it dies and falls off. The nature of the damage done is therefore a more or less heavy pruning of the young branches when the insect is abundant. This is serious enough when

Relations to the Forest.

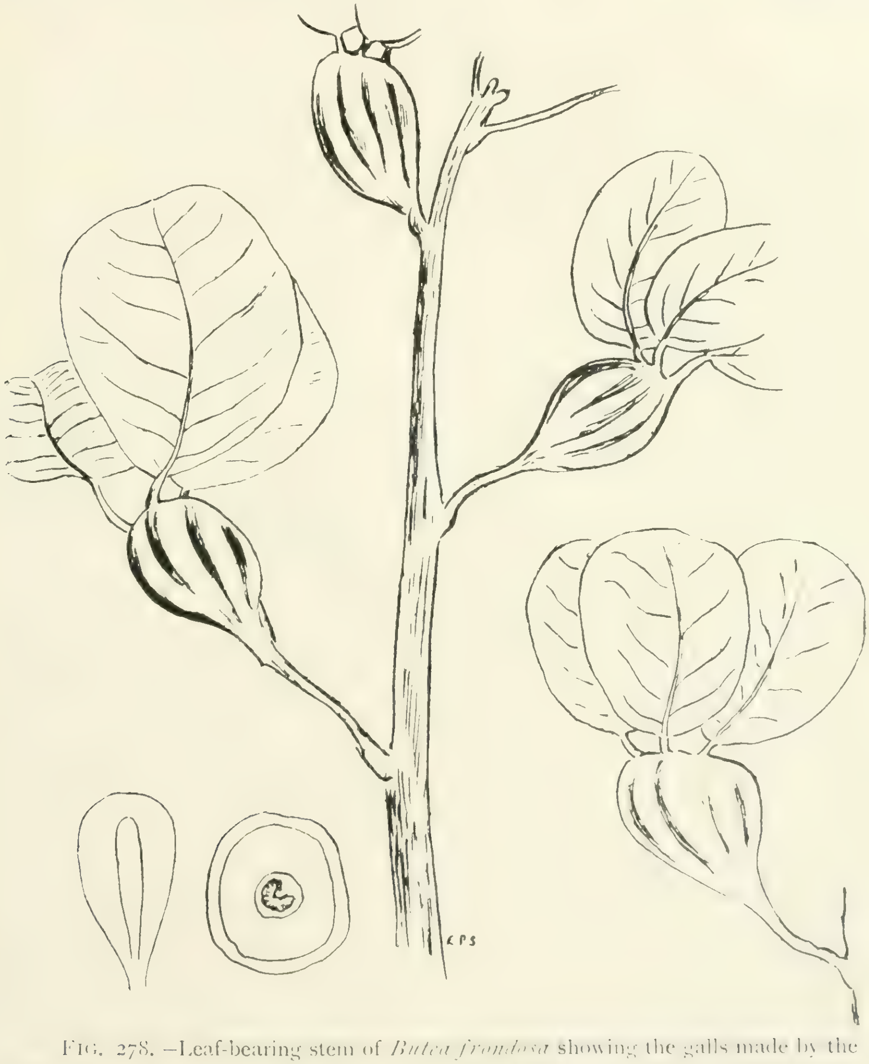


FIG. 278.—Leaf-bearing stem of *Butea frondosa* showing the galls made by the Palás-tree gall weevil (*Larinus* ? sp.). Sections of the galls, with a grub *in situ* in one of them, are shown. Central Provinces. (E. P. S.)

its effect on young trees is considered. The attack of the insect has, however, another aspect. The palás-tree is used for the cultivation of the lac insect throughout the Central Provinces, and the twigs infested and killed by

the weevil would be more usefully utilized for rearing the lac scales. For this reason the life history of this insect requires to be fully understood.

As to treatment, in years of bad infestation, as was the case in 1901, it should prove practicable in a lac plantation to lop off, collect, and burn the galls containing the larvae in the monsoon months. This would stamp out a bad attack.

Alcides.

Alcides porrectirostris, Marshall, sp. nov.

References.—Marshall, *Ann. Mag. Nat. Hist.* Aug. (p. 188) 1913; Stebbing, *Depart. Notes* (*Alcides* sp.), i, 38 (1902).

Habitat.—Bashahr State, North-West Himalaya.

Tree Attacked.—Walnut (*Juglans regia*). Taklesh, Songra, Baghi, Bashahr.

Description.

Beetle.—The beetle is black in colour, without scaling, with black antennae and legs, the latter clothed with yellowish-brown hairs. Head closely punctate, with a frontal fovea. The rostrum is straight and porrect (especially in ♀), slightly widened apically, striolate at base, strongly punctate in ♂, more finely in ♀. Antennae medium-sized, fairly thick; the scape is thickened at the joint, and the funiculus ends in a thick oval knob. Eyes large and elliptical in shape. Prothorax sub-conical, about as long as its basal width, the sides almost straight, upper surface with rather distant low granules, the apical area rugose. Scutellum oval, shallowly impressed. Elytra much broader than prothorax, shoulders very prominent and roundly rectangular; with regular rows of foveae, the intervals rather narrow, irregular, rugose, and sparsely set with very short curved pale setae. Body pubescent. Front legs longer than the others, the tibiae with a single internal tooth at the basal third. Legs coarsely punctate, femora comparatively slender with a fringe of long hairs beneath, and with a long sharp tooth close to apex. Length, 8 mm. to $9\frac{1}{2}$ mm.; breadth, $3\frac{3}{4}$ mm. to 4 mm. Fig. 279 shows a dorsal and side view of this beetle.

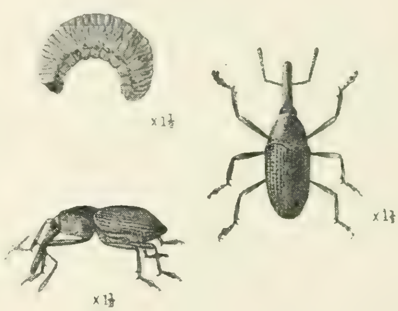


Fig. 279.—*Alcides porrectirostris*, Mshl., sp. nov. Larva and beetle. Bashahr, North-West Himalaya.

Larva.—The larva when full-grown is a fat white grub usually more or less curved, with twelve segments, the middle ones thicker than those at either end. Head small and bright yellow-brown in colour. Length, $\frac{3}{4}$ in. See fig. 279.

Pupa.—The pupa is of the ordinary curculionid shape.

Life History.

The beetle appears on the wing at about the beginning of August, but at present it is not known when or where it lays its eggs. Larvae were found full-fed in walnuts in the first week in July, and it is therefore probable either (1) that the weevil is to be found on the wing throughout the autumn, hibernating under bark or decaying leaves, stones, etc., on the ground, and coming out to lay its egg on or near the young ♀ flowers of the walnut in March or April;

or (2) it lays its eggs on the twigs near the young flower-buds in the autumn of the year in which it issues as a beetle. No external holes are to be found on the green outer covering of the walnut. I first noticed the attack in the Baghi Forest, Bashahr Division, my attention being attracted by the number of fallen walnuts littering the path beneath a large tree. I cut open some of these nuts and found in them the nearly mature fat curved grubs of this weevil. A large number of nuts were examined, and four to five grubs per nut appeared to be the usual number present, but in some cases eight, eleven, and in one or two as many as thirteen larvae were cut out of a single walnut.* The attacks of these grubs cause the fruit to wither, and about the first week in July the nuts drop from the tree and the larvae enter the earth and pupate there about the middle of the month. Fifteen to twenty days suffice for this stage, the first beetle obtained issuing on 4 August.

This weevil was discovered in the forests between Taklesh, Bahli, Songra, and Baghi, Bashahr State, North-West Himalaya, in 1901.

Relations to the Forest.

Many of the walnut-trees examined between the above-mentioned places had their entire crops of seed ruined by the attacks of the larvae of this curculionid. The effect of these operations within the nut is to reduce the inside to a black rotten mass of tissue and excrement in which the grubs live. The whole of the kernel and inner hard shell (endocarp) is reduced to this state, and only the hard outer green covering (pericarp), with a very thin layer of the inner shell, is left intact. No holes of any kind are to be seen on the outside of this green outer covering. By the time the inside of the nut is brought into this condition it falls to the ground, into which its weight, which is still considerable, causes it to sink. The period of this dropping of the nuts is also that at which the monsoon usually bursts over the hills, and the grubs consequently have no difficulty in entering the softened ground.

Alcides scenicus, Fst.

REFERENCE.—Fst. *Ann. Mus. Stor. Nat. Genova*, p. 256 (1894).

Habitat.—Darrang, Assam.

Tree Attacked.—India-rubber (*Ficus elastica*). Charduar Rubber Plantation, Darrang.

Beetle.—Elongate, with a long curved rostrum. Piceous brown with white markings. Head small, rostrum with a swelling half-way up, from which the antennae take off, broadest at top, black, shining, punctate, about half length of insect; scape of antenna black, thickened at top, rest brown. Prothorax widest behind, the basal margin V-shaped; strongly rugose except anteriorly, where it is smooth and finely punctate; three white narrow longitudinal stripes, one medianly,

Description.

* The nuts I collected were placed in a box containing a layer of moist earth. On leaving Simla on 17 July, Mr. J. H. Lace, at the time Assistant Inspector-General of Forests, kindly undertook to look after them for me, and he obtained the beetles.

the others on either side oblique, ending near outer lower angle. Elytra with basal margin deeply cleft medianly, depressed above base, strongly punctate-striate, the punctures on disk large and deep ; the surface irregularly raised ; constricted towards apex and depressed ; a short white longitudinal line in basal fourth near suture ; a diagonal one halfway up, a transverse irregular one in apical fourth. Under-surface and legs brownish black, punctate. Length (with rostrum), 11 mm.

Life History. This insect was observed pairing on 7 April 1906 in the Charduar Rubber Plantation in Assam. The insect was taken upon the rubber-trees. I was unable to discover where the eggs are laid, but the beetle appeared to be feeding on the latex of the plant.

Paramecops.

Paramecops farinosus, Wied.

Reference.—Wied. *Germ. Mag.* iv, 157 (1821).

Habitat.—Changa Manga, Punjab.

Tree Attacked.—*Calotropis* sp. Changa Manga Plantation, Punjab.

Beetle.—Elongate with a stout thick body. Black, covered with a white or greyish mealy powder. Head furnished with a long rostrum bent vertically downwards, the antennae placed about half-way up ; surface coarsely rugose, the vertex furnished with a fringe of short pubescence. Prothorax broadest behind, the sides with a sharp indentation just behind anterior margin which forms a transverse depression across thorax ; coarsely rugose. Elytra wider than prothorax, humeral angles oblique, sides gradually constricted to apical fifth, whence they are sharply constricted ; convex, sharply depressed behind ; coarsely striate-punctate, the striae most prominent on lateral edges, finer in apical portion, where the punctures become obsolete. Under-surface coarsely rugose. Legs rather long, anterior femora thickest. Length, 14 mm.

Description.

Life History. This insect was reported by Mr. B. O. Coventry in 1900 to feed on the epidermis of the ak plant (*Calotropis* sp.) at the Changa Manga Plantation. In the following year and again in 1905 I found the beetle feeding in this way and also on the leaves.

Lefroy in *Indian Insect Life* has the following note on this insect:—"The eggs are laid in the rind of the ak fruit, the little grubs boring into the soft tissues and feeding on the developing fibre and young seeds. The full-grown grub reaches a length of half an inch, and pupates in a compact cocoon formed of the delicate fibre. Ten days afterwards the adult emerges and feeds on the leaves of the ak plant."

Apion.

Apion strobilanthi, Desbroch.

Reference.—Desbroch. *Ind. Mus. Notes*, ii, 32.

Habitat.—Sikkim.

Plant Attacked.—Kibu (*Strobilanthus pectinatus*). Sikkim.

Beetle.—Oval oblong. Black with a bronze reflexion. Antennae light yellow, femora and tarsi brownish, rest of legs yellow; sides of thorax clothed with a greyish pubescence which appears on the elytra in three bands. Eyes large. Rostrum as long as head and prothorax together, moderately curved, slightly thickened at insertion of antennae, shining at the tip; antennae thin, inserted about two-thirds up rostrum, and about same length as latter, scrobes short. Prothorax lightly punctate, with a deep impressed line at base. Elytra about twice the length of prothorax, much wider, convex, striate-punctate. In ♂ the rostrum is more punctate and reddish in upper half. In ♀ the rostrum is black and smoother. Length, 2.5 mm. (without rostrum). Breadth, 1.5 mm.

Description.

This weevil was discovered by Mr. C. Gilbert Rogers, I.F.S., infesting the common fodder plant termed Kibu (*Strobilanthus pectinatus*), which is to be found in Sikkim at elevations of 6,000 ft. and thereabouts. The grubs feed on the seeds, completely destroying them. Mr. Rogers first took the beetle in the rains of 1889.

Life History.

EUGNAMPTUS.

Eugnamptus marginellus, Fst., var. semirufus, Fst.

Habitat.—Chanda, Central Provinces.

Tree Attacked.—Mango (*Mangifera indica*). Chanda (J. Martin, I.C.S.).

FIG. 280. *Eugnamptus marginellus*, Fst., var. *semirufus*, Fst. Chanda, Central Provinces.

Beetle.—Elongate, very small, the head and proboscis elongate and slender. Head brown, the prothorax orange-yellow; elytra black, shining. Head widest in front, the two large black eyes inserted on the outer anterior edge; surface smooth and shining and very slightly and finely punctate; proboscis elongate, narrow, basal half orange-yellow and finely punctate; anterior half black, broader anteriorly, punctate; the long black slender antennae inserted at the junction of the two colours, where proboscis is slightly swollen. Prothorax triangular, narrowest in front, joined on to the head by a "neck"; sides rounded; disk convex, punctate and shining. Scutellum triangular, punctate. Elytra broader than prothorax at base, widest in apical fourth, apices separately rounded; disk rather flat in basal half, finely striate and strongly punctate, the suture depressed for the greater length, the punctures large and distinct, swollen laterally, where striae are stronger; striae and punctures less well defined apically; surface covered with a short fine whitish pubescence; pygidium yellow. Under-surface yellow, with a rather dense short white pubescence. Femora thickened, black above, yellow beneath, rest of legs black. Length, 6 mm.

Description.

This weevil was reported by Mr. J. Martin, I.C.S., to injure the mango-trees in gardens in Chanda, in the Central Provinces. Mr. Martin observed that the weevil "bites off the leaves of the mango near their bases, and thus defoliates the trees."

Life History.

Nothing further appears to be recorded on the life history of the insect.

Curculio ? sp.

Reference.—Stebbing, *Ind. For. Mem. Ser. For. Zool.* ii.

Habitat.—Jaunsar and Tehri Garhwal, North-West Himalaya.

Tree Attacked.—Deodar (*Cedrus deodara*). Jaunsar, Tehri Garhwal.

Beetle.—Small, greyish brown, rostrum short, blunt, prothorax rather narrow. Elytra broader than prothorax, widest behind; longitudinally ridged and punctate. Length, 8 mm.

Life History.

I first discovered this weevil in June 1902. On the 24th of the month I took a few couples *in coitu* upon deodar branches. At this period the beetles feed upon the young new shoots. A couple were kept under observation in a breeding-box for nearly a week. In this period they destroyed two new green deodar shoots. The *modus operandi* of the beetle is first to bite off the needles at the top of the shoot, and then eat down the top of the stem for some distance. When the shoot becomes too thick for this operation, the insect peels off the epidermis, first biting off the needles to leave the former free. In this way most of the needles are destroyed and then the epidermis is removed.

I have not as yet taken this insect numerously in the deodar areas. Its method of attack, however, would be very serious in the event of its appearing in numbers in young plantations.

Apoderus.

An important genus of weevils who defoliate trees to provide a store of food for their larvae.

Apoderus incana, Stebbing.

Reference.—Stebbing, *Depart. Notes*, i, 189 (1903).

Habitat.—North-West Himalaya.

Trees Attacked.—Ban Oak (*Quercus incana*); Moru Oak (*Quercus dilatata*). F. Gleadow, V. Subramarian, and others, in Jaunsar; throughout oak areas in North-West Himalaya.

Description.

Beetle.—♀ The beetle is small, shining, dark yellow-brown with black markings on the elytra. Rostrum brown, short, broad, and armed at end with a pair of large mandibles. Antennae inserted near base, the scape short and inverted-cone shaped; funiculus fairly long, first joint small, second and third longer and of equal length and with the following ones increasing in breadth upwards to the elongated cone-shaped club, which is dark brown, the rest of antenna being yellow. Head short, semi-elliptical in shape, narrowing to a point posteriorly, dark

yellow-brown in colour. Prothorax joined to head by a short neck, widening posteriorly and having a raised collar where it joins the elytra. Scutellum small, black. Elytra much broader than thorax, a little longer than broad, widening slightly to their ends and deflexed here, only lightly covering the body, and leaving portions of two segments of the abdomen exposed ; yellow in colour, channelled at their bases, with two elongated black spots in their basal half; the external edge is raised and thickened slightly all round, and is crimson to dark red in colour, being especially bright at the suture. Abdomen thick, lighter yellow ventrally. Legs bright yellow, long, with their femora thickened ; two claws to end of tarsus. Length, 7 mm. Fig. 281, *a*, shows a dorsal and side view of this beetle.

Egg.—Yellow, shining, elliptical in shape, and about 1.6 mm. in length.

Life History.

These beetles appear on the wing about the close of the first week in May. The egg, larva, and perfect beetle are known. The insect when found was egg-laying, and for this purpose it attacks the leaves of both the oaks *Quercus incana* and *Q. dilatata*.

FIG. 281. *Apoderus incana*, Steb. *a*, weevil; *b*, branch of *Quercus incana* showing a rolled-up leaf ; *c*, a leaf cut and rolled up with the egg laid inside the roll. North-West Himalaya. (E. P. S.

The female beetle lays its egg in the left-hand corner of the apex of the leaf. The leaf is then, in the case of the *Quercus incana*, either cut across two-thirds of the way down, the cut being made on both sides from the exterior edge horizontally inwards till it meets the midrib, or the leaf is cut right across from one side to very near the edge of the other, only a small piece of the leaf-tissue being left. In either case the portion above the cut is folded inwards down the midrib and then rolled up from the apex downwards, the outer edges being tucked in so as to form a neat little cylinder which remains suspended to the lower part of the leaf by the uncut portion (see fig. *b*, *c*). This latter is, however, whether midrib or leaf-tissue, nicked across so as to ensure the little roll of leaf-tissue dropping to

the ground when it has become dry. In the case of the *Quercus dilatata* the procedure is much the same except that the leaf appears to be almost invariably cut lower down.

The method of egg-laying was studied by Mr. F. Gleadow, Deputy Director, Indian Forest School, Student V. Subramarian, and myself (for the first time) in May 1901.

A small grub hatches from the egg and feeds on the decaying tissues, becoming full-grown within ten days to a fortnight. The grub then leaves the roll, which will by now have reached the forest floor, and pupates in the soil.

The insects oviposit during a period of three weeks in May, but the number of eggs laid by each female has yet to be ascertained.

Relations to the Forest.

Throughout Jaunsar-Barwar and the adjacent Native States of Tehri Garhwal, Jubal, and Balsan, this insect was very plentiful in 1901 and 1902. The peculiar method of laying its eggs adopted by the insect results in the trees attacked being very heavily defoliated when the weevil is numerous. Trees of all ages are infested, and it is the newly unfolded leaves which are primarily treated in this manner, the older ones being only resorted to after the newer ones have been all occupied. Fig. 281, *b*, shows a portion of a branch with the upper leaves defoliated by this insect.

Methods of protection will be the same as those given below for the sissu *Apoderus*.

Apoderus sissu, Marshall, sp. nov.

REFERENCES.—Marshall, *Ann. Mag. Nat. Hist.* Feb. 1913; Stebbing, *Depart. Notes*, i, 33 (1902).

Habitat.—Sutlej Valley, Kulu and Bashahr States, 2,300 ft. to 3,500 ft.; Changa Manga, Punjab; Kumaun Terai Forests.

Tree Attacked.—Sissu (*Dalbergia sissoo*). Sutlej Valley; Changa Manga; Chor Galia, Kumaun Terai.

Description.

Beetle.—The female beetle is similar in colouring to the male, but is larger, being about a quarter of an inch in length, while the male is one-sixth of an inch. The general colour throughout the insect is a bright golden yellow. Head, thorax, and elytra are edged with black except at the outer upper edges of the elytra, where they are golden yellow. Snout and eyes are black. Antennae yellow at the base and furnished with black knobbed ends. Forehead between the eyes black. Elytra channelled, and they have three black patches situated triangularly on their upper halves, the patch at the apex being at the anterior end; the elytra are edged with black on their inner margins, and the anterior outer corner of each bears a light brown spot; they do not completely join at their bases, leaving several body segments exposed. Under-surface of the prothorax between the coxae a darker yellow-brown. Legs bright golden yellow. Fig. 282, *a*, shows dorsal and side views of the ♀ beetle, and *b*, dorsal and side view of the ♂.

Egg.—The eggs are pale yellow in colour, with a glistening surface, and about the size of a large pin's head. I have not yet seen the larva. It will probably be a small, whitish, curved, legless grub.

Life History.

The insect appears on the wing in June. From the 18th to the 20th of the month I found it in abundance actively engaged in laying its eggs. In a few cases the beetles were seen to be pairing, but this stage was evidently nearly over, as was evidenced by the fact that a large number of eggs had been already laid. My observations showed me that never more than one egg is laid on any one leaf. The mother beetle proceeds about her egg-laying in the following manner: Usually the egg is deposited to the left hand of the

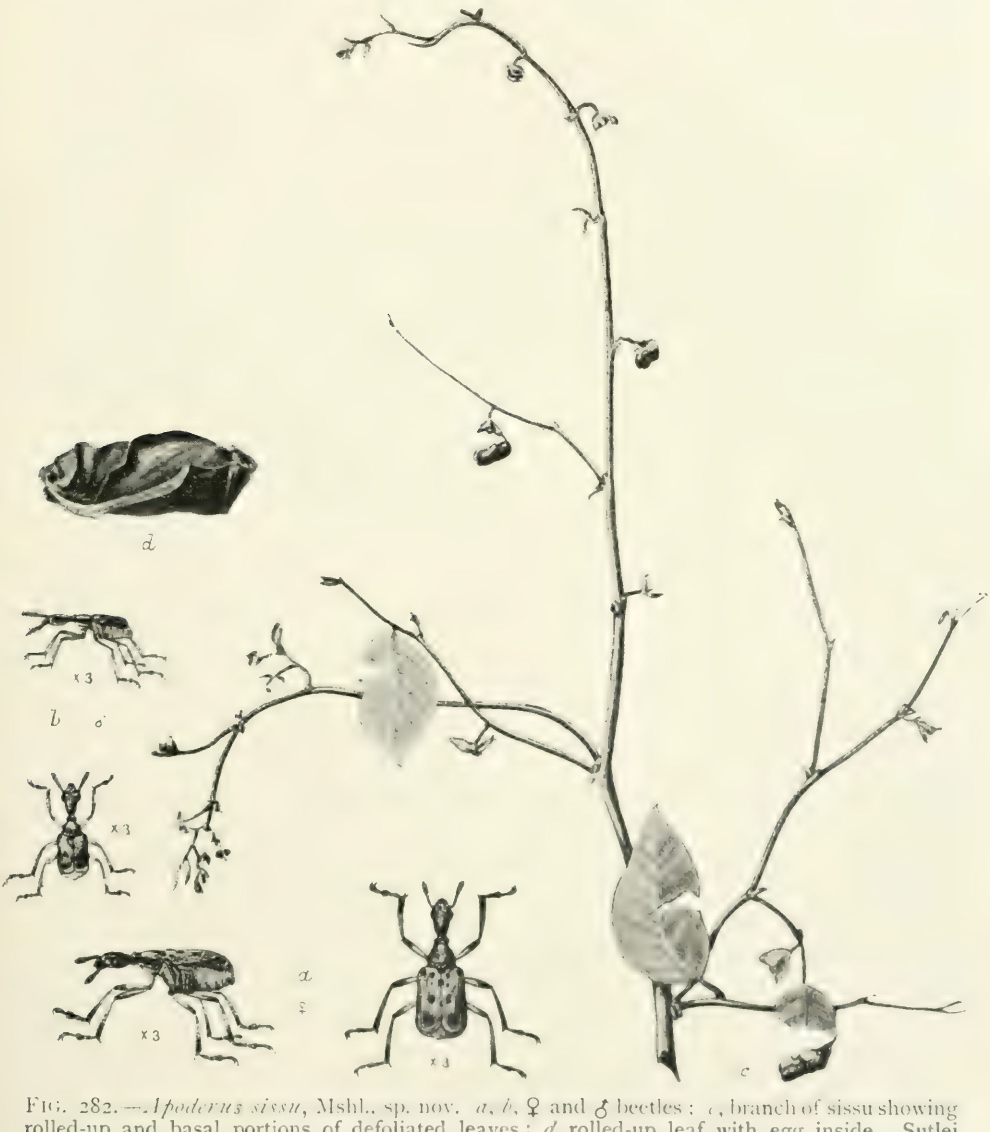


FIG. 282.—*Apoderus sissu*, Mshl., sp. nov. *a*, *b*, ♀ and ♂ beetles; *c*, branch of sissu showing rolled-up and basal portions of defoliated leaves; *d*, rolled-up leaf with egg inside. Sutlej Valley. (E. P. S.)

midrib near the apex of the leaf. The leaf is then folded along the midrib, the surfaces on each side being turned inwards. The beetle then rolls the leaf tightly up from the apex downwards, tucking in the outer edges, so that the ends on each side are symmetrical and the whole forms a tight little roll (fig. *d*). The end of the stalk where it expands into the blade of the leaf is then partially cut through, so that the little rolled-up mass hangs downwards. In other cases the beetle cuts the leaf at a point about one-eighth or at most one-sixth of the length of the leaf above its juncture with the leaf stalk. This is done in two ways: either the leaf is cut through right across by a horizontal incision, only a small portion of the outer edge being left to support the cut part; or the beetle cuts through the leaf horizontally on either side of the midrib, starting on each side from the outer edge of the leaf and cutting inwards to the midrib, which is only slightly notched. In each case the egg is laid in the same place and the leaf rolled up as above described. These little bundles containing each an egg hang down (see fig. *c*), suspended by the portion of midrib still uncut, or by the small portion of the outer edge of the leaf still intact, as the case may be; this small uncut portion soon dries up, and the little rolls then fall or get knocked off and drop to the ground (fig. *d*). I have not yet been able to ascertain how many eggs are laid by each beetle, but it is almost certain that more than one is laid, i.e. that several leaves are so treated by each beetle. From the eggs a small grub emerges which feeds upon the store of food thus provided by the mother beetle, subsequently penetrating into the soil and changing into the pupal state. In its method of procedure this beetle resembles *Apoderus incana*.

Relations to the Forest.

Whilst marching up the Sutlej Valley between Nirth and Rampur in June 1901 I noticed that the sissu-trees on either bank of the river were being heavily defoliated. The trees were growing either in clumps or scattered here and there in the river-bed and on the terraces existing on either side of the stream, An examination showed that the defoliation was not due to any ordinary leaf-feeding insect. A certain amount attributable to the latter cause was taking place, due to the *Myllocerus* weevils already alluded to on pp. 401, 402, but the serious part of the work was due to quite a different form of attack. The first thing that attracted notice was the fact that the crowns and ends of all the branches of the trees, consisting of long yellowish-green shoots just developed or in the course of development, were either totally leafless or rapidly becoming so. A closer inspection showed that these shoots were not entirely bare. In many cases small portions of leaves, looking as if they had been snipped off either just above the juncture of the stalk with the leaf or at the stalk itself, were visible, and often, hanging down from these, small bundles of rolled-up leaf. These latter enabled me to perceive what was taking place. A leaf-rolling insect was at work, and in each of these bundles, as already described, an egg had been

placed by the mother beetle, and in so laying their eggs the beetles were stripping the sissu-trees of the entire crop of their new leaves. In some cases the little bundles had dropped, in others they had turned black and were ready to do so, whilst others again were still green and fresh, and I was able myself to see others in the course of formation. Every tree on the sixteen miles of river I inspected both on the Kulu and Bashahr sides of the stream was either entirely defoliated of its new growth or rapidly becoming so, and there seems no reason for supposing that the attack did not spread some distance further, both up and down stream. The fact that the insect either rolls up the whole of the leaf or cuts it across very close to its base causes the complete destruction of all leaves attacked.

In addition to attacking the whole of the crop of new leaves, I noted that the beetle also laid its eggs on and rolled up the older leaves as well, though in nothing like the same proportion. It was probably the abundance of the beetles and the shortness of the supply of the new leaves that sent the insects to the old ones, as these must be infinitely more difficult to bend over and roll up than the soft, tender young ones.

I noticed in the Changa Manga Plantation in the third week of May 1905 some individuals of a weevil, since identified by Mr. G. A. K. Marshall as this species, on the young leaves of the sissu coppice in the compartment felled over the previous year. The insects were engaged in ovipositing, rolling up the young leaves of the plants in a manner similar to that above described. The young coppice had been defoliated to a certain extent by the insect.

I also observed this insect pairing and ovipositing on sissu-trees in the first half of May 1905 and again in 1908 at Chor Galia and neighbouring forests in the Kumaun and Garhwal Terai. The insect here oviposits on the new spring leaves of the tree in a manner similar to that already described for the Sutlej Valley. Each year a considerable amount of defoliation appears to be carried out by the weevil.

Protection and Remedies.

In the present state of our knowledge of economic entomology in India it is not always possible to consider remedies for application over large areas. The beetle probably has both fungous and insect enemies, and the larva likewise, the encouraging or introduction of which would keep it down. In nurseries and small valuable plantations the question is not so difficult. In such places I should advise the sweeping up into heaps of the small fallen leaf-rolls (each of which, it must be remembered, contains an egg or larva, and therefore a future beetle), and burning them *in situ*. This work will be very simple if carried out when the beetle is just finishing its egg-laying, as the ground then will be littered with the small rolls, and by jarring the young plants numbers will at once drop. In the case of small areas the ground could be gone over two or three times, to make sure of removing and killing off as many eggs as possible. Over larger ones one round would have to be sufficient, and it would be important to choose the right time, so that the maximum number of eggs possible might be destroyed. When the defoliation

is about three-fourths complete would be the best time to go round large areas. If the work is delayed longer, the larvae from the first-laid eggs will have left what remains of the small rolls and have gone into the ground, and it will then be too late to take steps against them unless ploughing or hoeing be resorted to, both of which would probably be out of the question as involving too large an outlay.

Apoderus ? sp.

Habitat.—South Coimbatore, Madras.

Tree Attacked.—*Dalbergia latifolia*. Mount Stuart, South Coimbatore.

Beetle.—Unknown.

Egg.—Large, egg-shaped, orange-yellow in colour. Length, 1.5 mm.

Larva.—Canary-yellow, shining, legless, the outer covering consisting of a fairly hard chitinous layer. Head yellowish brown with brown mouth-parts. Last three segments whitish to smoky. The thoracic segments are not much larger than the head, the first abdominal segment being enlarged, the succeeding ones tapering gradually to the anal one. Length, 4.7 mm.

Life History.

I have not taken this weevil in the imago stage, I think. It is probably distinct from the species of *Attelabus* dealt with below. For one thing its life history was in a more advanced stage, oviposition being over and in many cases the eggs hatched out towards the end of July, whereas the other weevils studied at the same time were still feeding and pairing and ovipositing in the forest.

The insect here treated of defoliates the *Dalbergia latifolia* in a manner similar to that of the *Apoderus* of the sissu (*D. sissoo*) in Northern India, cutting and rolling up the leaves as already described on page 419.

The *D. latifolia* trees in the forests round Mount Stuart were being heavily attacked towards the end of July 1902, enormous numbers of the leaves of the trees being rolled up in the egg-laying operations of the beetles.

Apoderus ? sp.

Habitat.—Moulmein, Tenasserim, Burma.

Tree Attacked.—*Cassia siamea*. Moulmein, Tenasserim.

Beetle.—Elongate, greyish, the female larger than the male insect.

This weevil was found defoliating the leaves of *Cassia siamea* on 5 March 1905. The beetles eat more or less roundish patches out of the edges of the leaves. Both sexes were present, and the insects were coupling.

ATTELABUS.

Attelabus discolor, Fährs.

REFERENCE.—Fährs. Schh. *Gen. Curc.* viii, 2, p. 232.

Habitat.—South Coimbatore, Madras. Also reported from Bombay.

Tree Attacked.—*Anogeissus latifolia*. Mount Stuart, Anamalai Hills, Walayan, South Coimbatore.

Beetle.—Moderately shining. Head and prothorax crimson, as also antennae, legs, and under-surface; elytra yellow, with three dorsal longitudinal lines, one-fourth up from base a transverse red band, and two short ones near apex placed between outermost longitudinal line and lateral edge of elytra; the latter edged all round with a crimson band. Antennae fairly long and clubbed. Legs long, the front legs greatly developed in length, and adapted for clinging to the edges of leaves, as the insects do not appear to walk readily on flat surfaces. Femora of front legs thickened. Length, 7.5 mm.

Description.

Egg.—Blunt-elliptical, pale yellow. Length, 1 mm.

Life History.

This weevil rolls up the leaves of *Anogeissus latifolia* after depositing an egg on the left-hand side of the midrib at the apex of the leaf. Usually the whole of the leaf is made use of, the cuts being made near the base. Infested trees may thus be completely defoliated. At Mount Stuart I found the insect in considerable numbers towards the end of July 1902, and at the commencement of the following month I again observed it in the Walayan Forest. I only noticed sapling growth infested, parts of it seriously, the whole of the leaves having been stripped off under the ovipositing operations of the beetles.

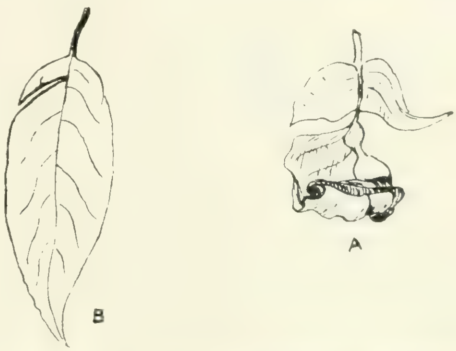


FIG. 283.—Leaves of *Anogeissus latifolia* attacked by the leaf-rolling weevil *Attelabus discolor*, Fährs. A, leaf cut across and rolled up and egg deposited in roll; B, leaf with first cut made in it just above the leaf-stalk. Anamalai Hills, South Coimbatore. (E. P. S.)

Attelabus octomaculata, Tekel.

REFERENCE.—Tekel. *Ins. Saund.* ii, 10?, not.


FIG. 284. *Attelabus octomaculata*, Tekel. Coimbatore.

Habitat.—South Coimbatore, Madras.

Tree Attacked.—*Grewia tiliaefolia*. Mount Stuart, South Coimbatore.

Beetle.—Orange or red, shining, with eight black spots, two placed transversely on the prothorax, and three others on each elytra, two placed one above the other in the basal two-thirds, and the third laterally in line with the upper one. Antennae black, short, knobbed, inserted close together in front of eyes; latter prominent, black. Legs long, especially the anterior pair, the femora thickened; latter red, rest below black. Under-surface a uniform Indian-red. Length, 6 mm. to 7 mm.

Description.

This small weevil cuts and rolls up the lime-tree-like leaves of *Grewia tiliaefolia* for egg-laying purposes. Owing to the size of the leaf, the beetle only makes use of a portion of it instead of the whole, as is the

case with the sissu *Apoderus*. The weevil makes two curved cuts below the apex of the leaf, until they meet the midrib about a third down from the apex, as shown in the sketch, and the portion between the cuts is then rolled up after an egg has been deposited near the apex (A). Another method of operation is to cut out a portion from the side of the leaf and roll this up along one of the side veins, D E and D F.

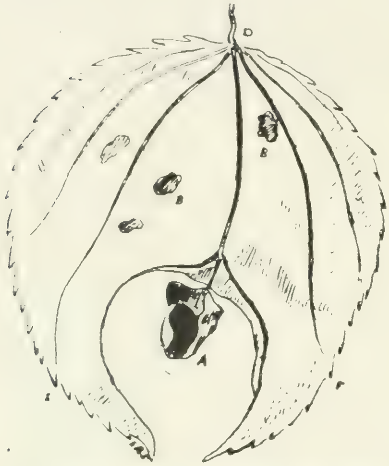


FIG. 285.—Leaf of *Grewia tiliaefolia* used by the weevil *Attelabus octomaculata* for egg-laying. A, part of the rolled-up leaf with egg inside. South Coimbatore, Madras. (E. P. S.)

In addition to making use of the leaf in this manner for ovipositing purposes, the weevil also feeds upon it, eating out small patches of the parenchyma, as shown at B in the figure.

I found the beetle fairly numerous in the forest round Mount Stuart, in South Coimbatore, towards the end of July 1902.

Attelabus sp.

Habitat.—South Coimbatore, Madras.

Trees Attacked.—Teak (*Tectona grandis*); *Helicteres* sp. Mount Stuart, South Coimbatore.

Beetle.—This beetle may be *A. discolor* described above, or a closely allied species.

Egg.—Pale yellow, shining, elliptical. Length, 1.17 mm.

Life History.

This weevil was found plentifully in the forests round Mount Stuart, in South Coimbatore, towards the end of July 1902. The beetle was feeding on the leaves of teak, and feeding and ovipositing on those of *Helicteres*. The teak-leaves had their edges cut and slit up under the attacks. The soft pubescent leaves of the *Helicteres* were skeletonized, the parenchyma of the leaf being eaten out, leaving a rough lace-work. Other leaves had portions eaten out of the edges, or patches eaten out of the interior, the veins being eaten as well as the parenchyma, as shown in the figure. This latter was the common method of attack in the case of the teak-leaves.

FIG. 286.
Leaf of *Helicteres* sp. gnawed by *Attelabus* sp. (E. P. S.)

A. *Pterocarpus dalbergioides.*—Leading shoot of a padouk sapling, two years old, which has escaped the attacks of the weevil *Trigonocolus subfasciatus*, Fst. B. B. Osmaston, Deputy Conservator of Forests, 21 July 1907.

The egg is deposited on the upper surface to the left of the midrib at the apex of the leaf in the case of the *Helicteres*, the left-hand side of the leaf being then folded inwards down the main vein and rolled up, the edges being tucked in. I did not observe the beetle ovipositing on the teak.

Trigonocolus.

The genus contains an important pest of the padauk in the Andaman Islands.

Trigonocolus subfasciatus, Fst.

(Andamans Padauk Weevil.)

Habitat.—Andaman Islands.

Tree Attacked.—Padauk (*Pterocarpus dalbergioides*). Andamans (B. B. Osmaston).

Description.

Beetle.—Broadly elliptical, small, the rostrum thick and slightly more than half length of body. Black, moderately shining; undersurface greyish, due to the presence of a fine dense pubescence. Head small, eyes large, inserted on lower edges; vertex punctate; rostrum long, thick, widest at upper end, curved downwards, punctate; antennae inserted two-thirds up, the scrobes placed laterally, the antennal club large, elongate elliptical, pubescent. Prothorax narrow in front, anterior margin straight, more than twice as wide behind, sides rounded, disk finely and transversely striate, anterior margin finely punctate. Scutellum large, transverse, punctate. Elytra wider than prothorax behind humeral angles, latter obliquely truncate, sides constricted sharply towards apex, apices separately rounded, exposing a small pygidium; striate and punctate, the punctures small, the interspaces broad and smooth. Length, 4.3 mm. to 4.7 mm.

FIG. 287. *Trigonocolus subfasciatus*, Fst. The Andamans Padauk Weevil. Andaman Islands.

Life History.

The attack of this small weevil pest on young padauk plants in the Andaman Islands was first discovered and reported by Mr. B. B. Osmaston, now Conservator of Forests, then in charge of the forests of the islands. The insect made its appearance in the tounggya padauk plantations, which were started near Port Blair about 1903. Pl. xxx shows the leading shoot of an unattacked two-year-old padauk sapling. The damage done is caused by the mature beetle, young shoots and leaders of seedlings and saplings being ringed by the weevil, presumably to afford sustenance for its offspring in the dying portion of the shoot. Plates xxxi to xxxv show the nature of the damage done by the insect.

In spite of careful search, however, Mr. Osmaston was unable to find either the egg, larva, or pupa of the weevil. The beetles appear on the wing chiefly in the wet months, Mr. Osmaston recording: "The damage is chiefly done in wet months, April to October, during which period the

attacks of the weevil are so systematically carried out that little or no height-growth can be put on. In the dry weather, i.e. November to March, the insect is scarce, and the majority of seedlings or saplings manage to put on a good shoot."

Mr. Osmaston wrote in 1905: "Nothing is known of the life history of this beetle or why it rings the small twigs, though it appears to suck the sap from the points where the injury is inflicted. I have not observed any indication of egg-laying in the shoots which are ringed."

No further observations on the life history have yet been recorded.

Relations to the Forest.

The weevil, so far as is known at present, infests young padauk plants only. The following notes upon its *modus operandi* are from Mr. Osmaston's reports. In October 1905 he wrote: "The nature of the damage consists in the ringing of all the young shoots, including the leader, at a stage when they are only an inch or two long, and about one-twelfth to one-sixteenth of an inch in diameter, but this ringing is so systematically carried out that the whole growth of the young tree is checked thereby. The young shoots fall off shortly after being ringed, and the sapling gradually assumes an unhealthy, bushy appearance with no definite leader (cf. pl. xxxiii and pl. xxxv). The seedlings are not much attacked until they reach a height of about 18 in., and from this point until they attain a height of about 6 ft. they suffer very seriously.

"It remains to be seen whether the plants will ultimately outgrow this insect pest, which at present appears to threaten the very existence of the plantations.

"The damage has been noticed for the last three years while tounggya plantations have been going on, but it is only lately that I succeeded in securing the insect which is responsible for it."

In August 1907 a further communication on the subject was received, together with an excellent series of dried parts of attacked plants showing the method of attack by the beetle. The photographs shown here were taken from the valuable series of specimens prepared by Mr. B. B. Osmaston. The following additional observations were recorded: "The tender shoot is punctured within an inch or two of its apex, and the juice is sucked out as it exudes."

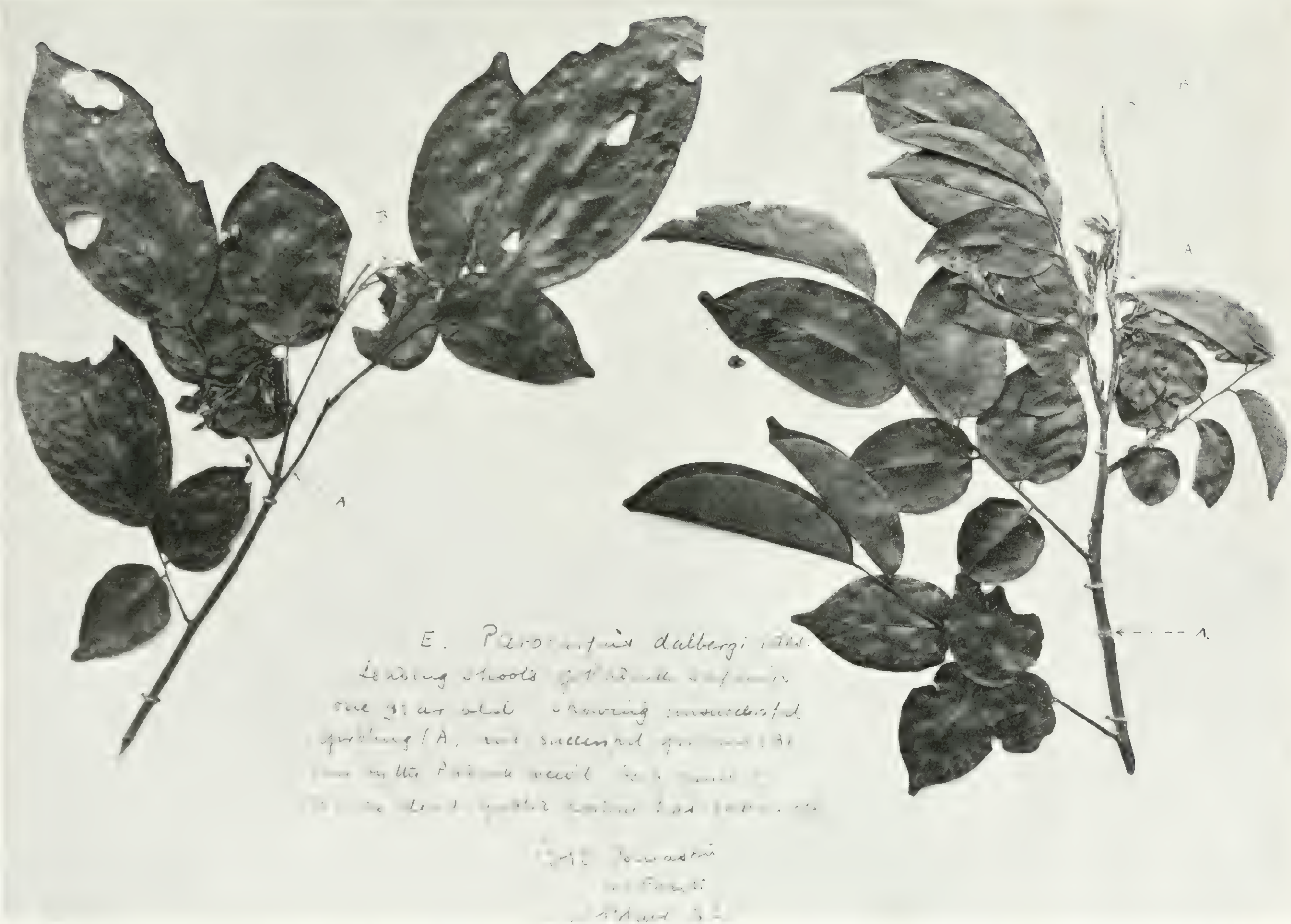
Marks of "unsuccessful ringing" are nearly always to be found lower down on the shoot attacked (cf. pl. xxxi, xxxii, and xxxiv). The object of this is not clear, unless it is done with a view to diminishing the flow of sap at the apex. Nothing whatever is known of the life history of this insect; neither the larva nor the pupa has been discovered as yet.

As we have seen, Mr. Osmaston says that in the dry months from November to March the greater number of the seedlings and saplings are able to put on a good shoot. In some cases, however, he states, the

B. *Pterocarpus dalbergioides*. Leading shoot of a padouk sapling, one year old, showing unsuccessful girdling (A) and successful girdling (B) by *Trigonocolus subfasciatus*, Fst. B. B. Osmaston, Deputy Conservator of Forests, Port Blair, 21 July 1907.

C. *Pterocarpus dalbergioides.*—Leading shoot of two-year-old sapling showing unsuccessful attempts at girdling (A) by *Trigonocolus subfasciatus*, Fst., and also where the girdling has been successful and the terminal shoots have fallen off. B. B. Osmaston, Deputy Conservator of Forests, Port Blair, 8 August 1907.

D. *Pterocarpus dalbergioides.*—Leading shoot of Padouk sapling, two years old, showing the effect of repeated attacks of the weevil *Trigonocolus subfasciatus*, Fst. B. B. Osmaston, Deputy Conservator of Forests, Andaman, 21 July 1907.



E. *Pterocarpus dalbergioides.* — Leading shoots of padouk saplings, one year old, showing unsuccessful girdling (A) and successful girdling (B) done by the padouk weevil *Trigonocolus subfasciatus*, Fst. As a result of (B) the dead girdled portion has fallen off. B. B. Osmaston, Deputy Conservator of Forests, Port Blair, 8 August 1907.

F. *Pterocarpus dalbergioides*.—Leading shoot of a padouk sapling, two years old, showing malformation resulting from repeated attacks of the weevil *Trigonocolus subfasciatus*, Fst. B. B. Osmaston, Deputy Conservator of Forests, Port Blair, 8 August 1907.

saplings after repeated insect attacks reach a stage when they appear unable to send up new shoots, as in the examples D and F shown in pl. xxxiii and pl. xxxv.

The fine series of plates exhibiting the attack of the weevil show (A) leading shoot of an unattacked sapling; (B) (E) a one-year-old seedling showing unsuccessful and successful girdling; (C) a two-year-old sapling showing the same; (D) (F) leading shoots of a two-year-old sapling showing malformation resulting from attacks.

MECISTOCERUS.

Mecistocerus raucus, Faust.

Habitat.—Salween River, Tenasserim.

Tree Attacked.—*Dalbergia* sp. (*cultrata ?*). Kowloon Island, Salween River.

Beetle.—Elongate, torpedo-shaped. Black, mottled with areas of silvery grey, largest and most prominent on the elytra; the legs coloured similarly. Head small, finely punctate; rostrum rather thin, curved and depressed, brown, punctate, not quite one-third length of insect. Prothorax widest behind, sides rounded; coarsely rugose-punctate, the punctures large and confluent on disk. Elytra slightly wider than prothorax, constricted in apical third, apex narrow, rounded; basal portion coarsely rugose, punctate and striate, the remainder more finely so; punctures and striae interrupted, save basally, by irregular areas of a very fine silky grey and yellowish pubescence, increasing in extent in apical part. Under-surface black, punctate, with a short greyish pubescence. Legs long, the femora thickened, with a prominent tooth three-fourths up on inner edge. Length, 6.3 mm.

Description.

FIG. 288.

Mecistocerus raucus, Faust. Salween River.

Life History.

I cut out a living specimen of this beetle from its pupal chamber in the sapwood of a large standing dead *Dalbergia* tree on Kowloon Island on 9 March 1905. The beetle was quite mature and ready to leave the tree. The gallery made by its grub was an irregular winding one, eaten out in the bast and sapwood.

Mecistocerus ? fluctiger, Faust.

REFERENCE.—Stebbing, *Cryptorhynchus* sp. *Injur. Ins. Ind. For.* p. 61 (1899).

Habitat.—Eastern Himalaya.

Tree Attacked.—White Siris (*Albizzia procera*). Tista Valley, Sikkim; elevation about 1,000 ft.

Beetle.—Yellowish brown to dark brown, of typical cryptorhynchid shape. About one-third inch in length. Three parts mature only.

Life History.

From a white siris-tree blown down in the Tista Valley forests during the previous monsoon I obtained a number of specimens of this beetle in April 1896. The eggs had been evidently laid in the tree some time in the previous autumn, and the

grubs on hatching had eaten out long irregular longitudinal galleries in the bast and sapwood, the tunnels grooving the latter somewhat deeply. On becoming full-fed the larvae penetrated into the wood to pupate. The stem of the tree contained numbers of the pupal chambers at distances varying from a half to one and a half inches down in the sapwood. The beetles would probably issue some time early in May, and there are perhaps two generations in the year, or one and a half generations, resulting in the over-lapping of the life-cycles.

Mecistocerus ? sp.

REFERENCE.—Stebbing, *Injur. Ins. Ind. For.* p. 61 (1899).

Habitat.—Eastern Himalaya.

Tree Attacked.—Kadam (*Anthocephalus cadamba*, Miq.). Tista Valley Sikkim ; elevation about 1,000 ft.

Beetle.—Unknown. May be identical with above.

Cocoon.—The grub pupates in a loose semi-elliptical cocoon made of chips of wood and bark. (See fig. 49 in pl. ix in *Injurious Insects of Indian Forests.*)

Pupa.—The pupa is elongate, narrow, yellowish white, and has the shape of a *Mecistocerus* beetle.

Life History.

I took numerous specimens of the pupa and cocoons of this weevil in the Tista Valley in April 1896. The pupal cases were situated between the bark and wood, the larva having eaten out an elliptical-shaped depression, of which half was in the sapwood, whilst the other half was situated in the inner bark. The grub itself eats out irregularly winding longitudinal galleries in the bast and sapwood. The tree in which the pupae were found was still alive, but was dying, the greater portion of the cambium layer in the lower part of the trunk having been removed. I have not been able to procure mature specimens of the insect for identification.

CRYPTORHYNCHUS.

A very important forest genus of weevils whose grubs eat out galleries in the bast and sapwood, often causing the death of trees.

Cryptorhynchus brandisi, Stebbing.

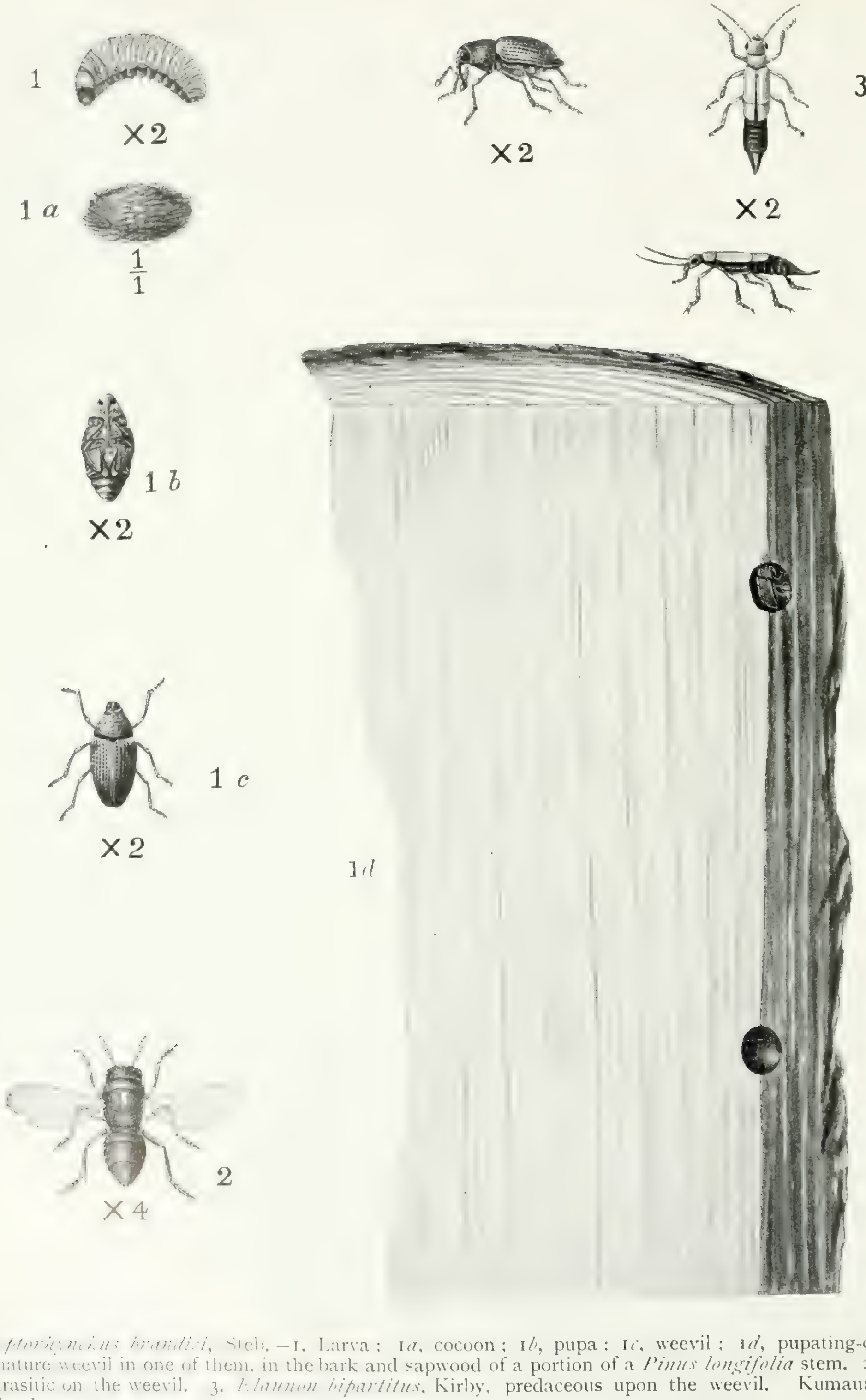
(*The Chir Pine Weevil.*)

REFERENCES.—Stebbing, *Ind. For. Mem. For. Zool. Ser.* vol. ii, pt. ii, p. 73 ; id. *Depart. Notes* (*Cryptorhynchus* sp.), i, 41 (1902).

Habitat.—North-West Himalaya ; Shillong, Assam ; Maymyo, Upper Burma.

Trees Attacked.—Chir Pine (*Pinus longifolia*) : Kumaun (R. C. Milward *et mihi*), Jaunsar, Tehri Garhwal, Chamba (*mihi*) ; *Pinus khasya :* Maymyo (G. R. Long, D. A. Allan, *et mihi*), Shillong (*mihi*).

Plate XXXVI.



Cryptorhynchus brandisi, Steb.—1. Larva: 1*a*, cocoon; 1*b*, pupa; 1*c*, weevil; 1*d*, pupating-chambers, with a mature weevil in one of them, in the bark and sapwood of a portion of a *Pinus longifolia* stem. 2. Cuckoo wasp parasitic on the weevil. 3. *Elaunon bipartitus*, Kirby, predaceous upon the weevil. Kumaun, North-West Himalaya.

Beetle.—Elongate-ovate. Head and rostrum black; elytra reddish brown, with a sparse greyish pubescence, most prominent laterally. Head finely punctate, the rostrum a little more than a quarter the length of the insect, not very thick, and tapering slightly to apex, curved, punctate, and medianly carinate; the scrobes commence a little above middle of rostrum, slightly oblique, directed upwards to where the bases of antennae take off; antennae fairly stout, inserted slightly above middle, scape swollen into a knob at point of junction with funiculus, latter ends in an oblique oval knob; eyes strongly facetted. Prothorax triangular, tapering anteriorly, sides rounded, transversely channelled just below anterior edge; a narrow, median, longitudinal, keel-shaped carina starting from anterior third and not reaching base; rest of surface very coarsely rugose-punctate and reticulate. Scutellum round. Elytra widest basally, humeral angles truncate, sides rounded and constricted, apices separately rounded; a small white blotch about their centre and a larger one towards the posterior extremity; broadly striate and finely punctate, the striae interrupted by some large deep punctures placed at intervals. Under-surface dark red-brown, punctate, with a short, sparse, yellow pubescence. Legs pubescent and punctate; femora thickened anteriorly, the posterior ones not reaching to end of the abdomen. Length, 6.6 mm. to 8.5 mm. Pl. xxxvi, fig. 1*c*, shows a dorsal and side view of the beetle.

Description.

I have here revised and added to the description of this insect given in *Indian Forest Memoirs*, ii, 73 (1911).

Larva.—A fat yellowish-white rather curved grub. Head well marked, dark yellow. Prothoracic segments swollen and corrugated with a horny plate dorsally. Body corrugated, the segments constricted posteriorly to a blunt point. Length, ½ in. Fig. 1.

Pupa.—Yellowish white, thick and blunt-ended. Somewhat ovate. Wings and legs are pressed against the cheek. Also antennae. Fig. 1*b*.

Cocoon.—Blunt-elliptical with rounded curved sides. It is made of shredded bark and wood strips loosely bound together so as to fit fairly tightly into the elliptical-shaped hole gnawed out of the sapwood and bark for its reception. Fig. 1*a*.

Life History.

This weevil pest has a somewhat wide distribution in the forests of India, stretching from the western portion of the Himalaya to Maymyo in Upper Burma so far as is at present known. The fact that the weevil known to infest the *Pinus khasya* in Assam and Upper Burma is identical with the pest of the *Pinus longifolia* of the Western Himalaya, a point definitively set at rest by Mr. Marshall, is a fact of considerable importance and significance to the well-being of the forests in these regions.

Life History in the North-West Himalaya.

The female beetle crawls into the deep crevices in the bark of the tree, and lays her eggs, probably singly, in the smaller crevices of the thin lower layers of bark, or pierces down to the cambium layer and places them there. The young larvae on hatching out remain in the thinnest portion of the cambium layer, at first eating out a small gallery in an irregular fashion. As it increases in size the grub eats out a deeper gallery in the thick cambium and bark, the gallery also grooving the sapwood. This gallery has always a very irregular shape, and gradually increases in diameter as the grub grows larger. The gallery may be very irregular and winding, proceeding round the circumference of the tree, or it may proceed up or down the tree in a more or less winding vertical manner, the gallery having small horizontal bends in it at intervals, due to the fact that the larva has for a

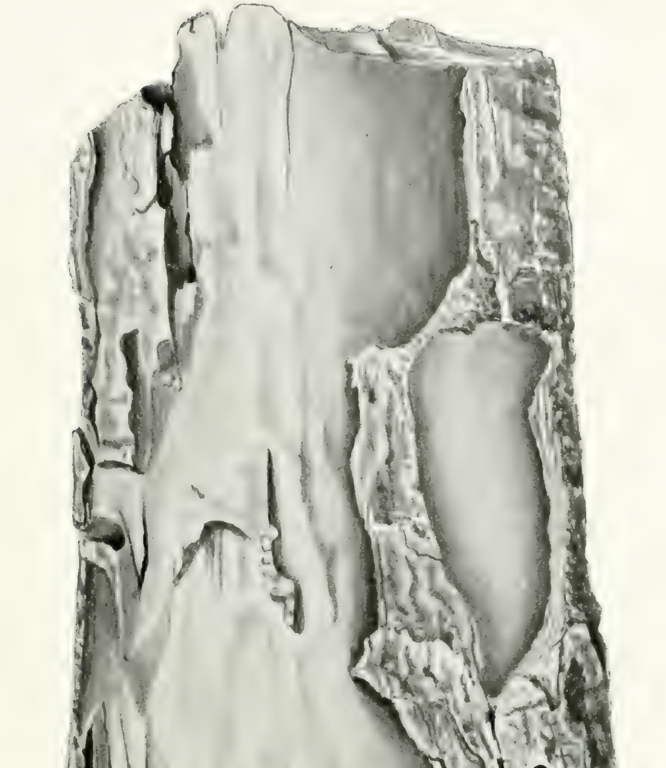
time taken to boring horizontally instead of vertically. It may be possible that these horizontal portions in the gallery are made just before one of the moultings of its skin which take place periodically during the growth in size of the grub. When the grub has reached full growth, and just before pupating, the gallery is often curved at right angles to its previous direction, and the larva then eats out the pupating-chamber in the sapwood and bark. In fig. 23 a grub is shown in this position at the top of the stem.

As has been said, the gallery increases in size with the development in bulk of the insect, so that by the time the grub approaches full growth the gallery is from three to four times the breadth of its occupant. The larval gallery is always filled with loosely packed ejected wood-dust and wood excreta containing short strands of ligneous wood fibres. Owing to its irregular method of feeding the length and breadth of the larval galleries vary very greatly, but galleries have been measured as long as 9 in. in length, whilst others have wound about in an area of bark 6 in. to 8 in. square. Fig. 23 and pl. xxxvii show the larval galleries in the cambium and sapwood.

The position of pupation appears to vary according to the size of the tree attacked and consequent thickness of the bark present. In the case of old trees where the bark is very thick the insect eats out an elliptical pupating-chamber which is made entirely in the inner bark of the trees and does not groove the sapwood. This chamber or cradle is lined with particles of bark fibres forming a rough loose cocoon in which the larva pupates. In the case of young trees, on the other hand, the larva eats out an elliptical depression in the sapwood about half to three-quarters of an inch in length and having the appearance of a small kind of cradle. The other half of this ellipse is eaten out in the cambium layer (see fig. 1*d*, in which a newly matured beetle is shown *in situ* in the cradle) and bark, and the two halves are then lined with a thick interwoven mass of stringy wood-fibres which fits rather tightly into the cradle (pl. xxxvii). In this cocoon the larva changes into the pupal stage.

When the beetle is fully mature, and consequently ready to leave the tree, it bites out a circular hole at one end of the cocoon (fig. xxxvii, the lower of the two cocoons shown), and, crawling out of this, bores a large circular hole through the thick bark of the tree, and thus escapes from it. These holes have a considerable diameter, and are easily visible even in the thick bark which this tree puts on (*vide* pl. xxxvii). Observations of attacked trees have shown that the newly mature weevils do not always get out of the tree in safety, owing to the outflow of resin which at times catches the beetles whilst engaged in boring their way through the bark and drowns them. Instances of this have been observed *in situ* in the trees.

It is difficult at present to state with any certainty the number of generations which this weevil passes through in the year, since the insect is so often found in the tree in all three of its stages of larva, pupa, and beetle. I am inclined to consider, however, that the insect has normally three genera-



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Portion of the stem of a young *Pinus longifolia* showing the attacks of the larvae of *Cryptorhynchus brandisi*, Steb., in the bast and sapwood. Two cocoons are shown *in situ* and exit-holes of the matured weevils in the bark. Jaunsar, North-West Himalaya.

tions in the year, but that these generations overlap very greatly, thus giving rise to the appearance of there being an almost continuous succession of larvae and pupae in the trees throughout the year. An examination of infested trees at the commencement of the winter (about the middle of November) will show that almost mature and immature beetles are present in the pupal cradles, and that these pass through the winter in this position. The larvae in the trees which have not as yet pupated will probably all pupate before the severe cold commences, so that the winter is probably chiefly passed in the pupal or mature-beetle condition. We have no data at present as to when this insect commences work at the beginning of the season, but it would probably be some time in April at the latest, the pupae maturing and the mature beetles egg-laying some time during this month. Observations carried out by myself in 1908 in Kumaun have shown that a generation of beetles matures and issues about the first week in June, and probably lays eggs about the middle of that month. The larvae from these eggs have been found to give rise to the full-grown larvae, pupae, and immature beetles reported by Mr. Milward as infesting trees in the Almora plantations at the beginning of September, the generation of beetles maturing about the middle of September and laying eggs towards the latter part of that month. The larvae arising from these eggs were found half-grown in the middle of October in the trees examined by myself in Jaunsar in 1906, and this forms the over-wintering generation of the insect. We thus have three generations, in which the mature-beetle (i.e. egg) and pupal stages are from a week to a fortnight in duration, whilst the larval stage (that is, the period during which the chief damage is done to the tree) lasts roughly from six to eight weeks. The hibernation probably lasts for some four months, from December to the end of March. Of course elevation and severe or mild winters will greatly modify the duration of this period, and consequently the date of appearance of the various generations, which, *du reste*, necessarily overlap owing to the insect commencing the year in both the pupal and perfect-insect stages; the eggs laid by the latter as soon as the weather is favourable thus having the start over the ones laid by the beetles which have first to mature from the pupal stage through which the winter has been passed.

Life History in Upper Burma and Assam.

In December 1901 Mr. G. R. Long, I.F.S., forwarded me a consignment of larvae, pupae, and imagoes of this weevil, with the information that they were infesting an experimental plantation of *Pinus khasya* at Maymyo, Upper Burma. Mr. D. A. Allan, Forest Ranger, had drawn his attention to the attacks. In February 1905 I had an opportunity of visiting the plantation in question and of inspecting other planted trees in the station. At this period I also found the insect in all stages in the trees. The following year I found the beetle in large numbers in *Pinus khasya* trees in Shillong in Assam towards the end of April, but discovered no larvae or pupae.

From these observations it would seem that the insect appears on the wing earlier in the year at Maymyo (3,500 ft.) than in Assam; it is quite possible that in Burma the generations overlap and that the insect never ceases work in a climate where but little cold is experienced throughout the year. At Shillong (5,500 ft.) the beetles taken so numerously were probably the first beetles of the year engaged in laying the eggs of the first brood.

The mode of attack of the insect in *Pinus khasya* is very similar to that in *Pinus longifolia*. The larvae live in the bast and sapwood, grooving out elongate irregular broad galleries. When full-fed they gnaw out a cavity in the bast and sapwood, line it with bark- and wood-fibres, and pupate in this. These bark- and wood-fibres are fresh and moist when the cavity contains newly pupated larvae, whereas by the time the beetle has reached the resting stage the fibre lining of the cavity has become dry and yellow. When mature the weevil eats a hole straight through the thick bark and crawls through it to the outside of the tree.

Relations to the Forest.

The damage arising from the presence of this insect in a forest is two-fold—(*a*) It attacks young green standing growth of all kinds from the moment that the seedlings have developed a bark thick enough for the larvae to feed in. This bark in the case of the *Pinus longifolia* is developed at a very early age, often in trees as young as three to four years old. (*b*) The beetle attacks with equal facility green trees of all ages up to old standing trees of large size, laying its eggs either deep down in crevices in the thick bark at the base of the tree or anywhere in the bole higher up and in the crown. A standing green apparently healthy tree of 14 ft. girth was found attacked in this manner in Jaunsar in November 1906.

The beetle must be looked upon, as is the case with many of the weevil family, as particularly hardy and resistant to outside influences; and this is so both in the larval and mature-beetle stages. The larvae once hatched would seem to have more than the usual chances of reaching maturity, since they are to be found wallowing in the outflow of resin poured out by the tree in answer to their operations in the bast layer; the resin appears to be particularly palatable to them. The powers of multiplication of the beetle also seem to be considerable.

The danger of an insect of this nature gradually increasing in numbers and acquiring a hold over a forest is of course much greater in the case of pure forests than in that of mixed ones, and this danger is existent in this instance, since the *Pinus longifolia* is to be found pure over considerable areas in the North-West Himalaya.

In Burma Mr. Long's investigation of the attacks of the beetle in *Pinus khasya* was limited to five-year-old trees in a plantation situated at 3,200 ft. elevation, and only trees on a southern aspect were noted as infested, those on a northern aspect but 200 yards away being unattacked. Mr. Long noted that the woody tissues, often to the centre of the tree, were

stained blue as though by fungoid mycelia, and was inclined to think that the chief damage was due to the fungus. Subsequent investigation has not, however, upheld this surmise.

In February 1905 I visited this plantation at Maymyo, which now forms part of the grounds of The Lodge, the summer residence of the Lieutenant-Governor of Burma. As a result of the investigations made the following points were established :—

(1) That the insect is to be found in the trees in all stages of grub, pupa, and beetle in the middle of February.

(2) That it will apparently attack poles as well as saplings, since recently killed poles were ten years old, their outer bark quite thick and rough; and that trees seriously infested will be killed.

(3) That it will attack trees on any aspect—not only on a southern one. The attack investigated in 1905 was situated at some distance from the infested trees discovered by Mr. Long.

(4) That the insect was a difficult one to deal with in this locality, since in spite of the efforts made to stamp it out in 1902 it was abundant in 1905, and appeared to be spreading throughout the station owing to the large amount of planting which was accompanying the increased building operations.

In Shillong in April 1906 I found the weevil abundant. Numbers of beetles were cut out from the bark and sapwood of recently felled unbarked logs in the forest. Others were found on the under-surface of the log, sheltered from the sun in interstices of the bark.

Other evidence of the abundance of this insect in the forest round the station was to be found in the dead poles used to fence in the jumping schools near the polo ground, and in fact for fences of all kinds throughout the place. Large round holes were visible in the bark, and if the latter was removed the elliptical chambers filled with masses of wood- and bark-fibre were to be seen; or, if the bark had fallen off, the semi-elliptical depressions in the sapwood formed sufficient evidence of the former presence of the beetle. And such were very numerous.

Protection and Remedial Measures.

Protection and remedial measures against this weevil, although a somewhat difficult matter, are quite feasible when the pest has to be dealt with in plantations. The first step to be taken is to determine accurately the dates during the year at which the trees in any particular locality contain larvae, pupae, and immature beetles. Having decided upon these periods, the whole of the infested trees should be cut out and burnt. Badly infested trees can easily be recognized owing to the fact that their needles commence to turn yellow and the tree begins to fade. In the case of young plantations a little careful observation on the part of Forest Guards should make it possible for them to be able to mark down attacked trees upon which the needles have not yet turned yellow, since the bark of the trees is invariably coated with a mass

of resin exuding from the holes of mature beetles which have found their way out of the trees. It is by means of these resin masses (which in badly infested older poles and large trees thickly coat the bark, more especially in the regions where the side branches take off from the main stem) that an attack can be marked down.

As in the case of young trees in plantations, so in that of older trees in the forest, the only plan to prevent the attack spreading to uninfested trees is to cut out the infested ones, strip off the bark, and burn it. To be satisfactory this must be done at the periods when the insect is in the larval and immature-beetle stage. This, in the Western Himalaya, would be towards the end of May, middle of August, or during the long winter period of hibernation. In fact, where possible, I should always advise remedial measures against this pest being undertaken during the period of hibernation. At this season there are no beetles on the wing in the forest, so that it is possible to ensure killing off the whole of the insects which are responsible for the dying condition of the trees, thus clearing effectually a plantation or an area of forest from the pest.

In the case of severe infestations of the weevil the provision of trap trees is recommended, the trees to be felled and barked as soon as they are full of larvae. This operation will require careful watching and inspection in localities where the generations of the insect overlap, and it may be found necessary to burn or completely char the stems of the trees after felling, instead of barking them. Barking will not be sufficient to kill semi-mature or "resting" beetles. These would simply fall into the undergrowth, mature there, and in time carry on the infestation.

It must be borne in mind, however, that it will be of little use clearing one set of infested areas of the beetles if other affected areas in the neighbourhood are left untended. And this applies more particularly to the Kumaun *P. longifolia* forests. In this region there are a number of district forests which are not under the management of the Forest Department,* and through which annual fires are allowed to run unchecked, and mutilation of the forest growth on the area takes place. It is in such areas that the weevil has the greatest scope for increasing rapidly, for it finds here large numbers of trees weakened by fire and mutilation which serve it as exceptionally fine breeding-places. I personally examined several areas of this kind in 1909, in all of which I found the weevil in abundance. It is probable that the greatest difficulty to be faced in endeavouring to prevent the spread of this pest on a large scale throughout the *P. longifolia* forests confronts one in the presence of these areas of fire-swept and mutilated forests of Naini Tal and the Kumaun districts. Not only do these areas serve as breeding-grounds of the weevil, but they are equally favourable to the multiplication of the buprestids *Capnodis* and *Anthaxia*, the *Nothorrhina* longicorn beetle (pp. 202, 212, 281), and the dangerous *Noctua* moth bast-eating caterpillar.

* I understand that these areas have now been placed in charge of the Department.

The condition of the Baldhoti and Kalimath plantations in 1909, especially the latter, clearly shows the danger arising from and the difficulties to be faced in connection with the state of the district *P. longifolia* forests. I was given to understand by the Commissioner of the Kumaun Division that District Officers were engaged in forming plantations of *P. longifolia*. There can be little hope of their proving successful unless the destruction going on in the Civil forests is put an end to and an effective check on the increase of the beetles thus established.

In Shillong careful attention will have to be paid to this insect if it is to be prevented from acquiring a strong hold over the beautiful *Pinus khasya* woods surrounding the station. My inspection in 1906 showed that the heavy and unregulated fellings being made in these woods would inevitably lead to a large increase in the numbers of this pest.

Parasitic and Predaceous Foes in North-West Himalaya.

Ichneumon sp.—The grub of this fly is parasitic upon the weevil larva, feeding upon the fatty tissues of the latter and causing its death from exhaustion after it has reached full development.

Fly.—Small, yellowish in colour, with four iridescent wings. Body curved and armed with three long fine hairs or styles at posterior end.

Larva.—A minute white grub almost translucent in colour, with head pale canary-yellow.

Life History.—I have found this insect but sparingly in *Pinus longifolia*. The only stage taken is that of the mature Ichneumon fly, which was found in the characteristic pupal chamber made by the weevil larva. It is probable that the fly deposits its eggs close to those laid by the weevil in crevices of the bark of the tree or in the neighbourhood of or on the newly hatched weevil grub. I have not yet discovered whether the Ichneumon grub feeds on the weevil larva as an external or internal parasite. The weevil grub is evidently not killed until it has finished the construction of the pupal chamber. It then dies, and the hymenopterous parasite pupates. The mature fly evidently issues from the tree at the same time as the weevil beetles, since both were found maturing or mature and leaving the tree at the Baldhoti Plantation near Almora in the first week of June.

There is a good deal still to be learnt about this most useful parasite. Exactly where the eggs are laid and whether more than one Ichneumon larva parasitizes each weevil grub are important points to ascertain. Also whether the insect, as is probable, passes through the same number of life-cycles as its host.

Cuckoo-wasp.—The small Cuckoo-wasp figured in pl. xxxvi, fig. 2, was taken by myself from one of the pupating-chambers of the weevil in a young tree. The fly was just mature. It would appear probable that the insect lays its eggs in the weevil grubs, and that the young Cuckoo-wasp larvae feed upon and eventually kill the weevil grubs. The point is of great interest, for it is the first record I have of the Cuckoo-wasps being of use in the Indian forests as parasites of noxious tree-pests.

Elaunon bipartitus, Kirby.—Predaceous upon *C. brandisi*.

Mature Insect.—Elongate narrow. Brown; the forewings bright canary-yellow. Antennae and legs slender, yellow. Length, 1 in. Pl. xxxvi, fig. 3, shows a dorsal and side view of the insect.

Life History.—The grub of this earwig is, I think, predaceous upon the grubs of the cryptorhynchid weevil.

I took a number of fully mature insects from the dying tree felled in the Baldhoti Plantation on 8 June, and others subsequently in the young dying trees in the Kalimath Plantation. The earwigs were found between the bast and sapwood.

I know nothing further about this insect.

Cryptorhynchus gravis, Fabr.

Habitat.—United Provinces, Bengal, Assam.

Tree Attacked.—Mango (*Mangifera indica*).

Description.

Beetle.—Rusty brown to blackish brown in colour, mottled with greyish patches. Proboscis long, bent vertically downwards, apical portion black, antennae inserted half-way up. Prothorax triangular, of less width than elytra, finely rugose. Elytra covered with longitudinal rows of yellowish scales, strongly striate-punctate, widest at base, thence gradually constricting to apex, which is depressed and slightly constricted. Length, 9 mm.; breadth, 3 mm.

Larva.—White, fleshy, legless, and corrugated.

FIG. 289. *Cryptorhynchus gravis*, Fabr. Northern India, Bengal, Assam.

Life History.

This weevil is the common pest of mangoes in Northern India. Many must be acquainted with both grub and weevil, since they are often found within the fruit. The eggs are laid in March or April on the young newly formed mango fruit, the larvae feeding in the stone. When full-fed, by which time the infested mango will have fallen to the ground, the grub eats its way through the fruit and pupates in the soil, emerging in late June and July and on into August as a perfect beetle. These beetles pass through the monsoon and following winter in this stage, and lay their eggs in March or April of the following year.

Cryptorhynchus mangiferae, Fabr.

REFERENCE.—Fabr. *Syst. Ent.* p. 139.

The life history of this insect in its main details is similar to that of *C. gravis*. It is not impossible, however, that it may pass through two generations in the year.

According to Lefroy (*Indian Insect Life*) it is confined to South India and Ceylon.

Cryptorhynchus raja, Stebbing, sp. nov.

Habitat.—Chamba State, Tehri Garhwal, North-West Himalaya.

Trees Attacked.—Blue Pine (*Pinus excelsa*): Bré Forest, Chamba; Spruce: Deota, Tehri Garhwal.

Description.

Beetle.—Elongate, rather narrow. Black, dull, with very small patches and tufts of a greenish-orange pubescence. Head finely rugose, small, with a slight coppery reflexion which extends down on to the basal half of rostrum; latter not quite a third length of insect, the basal half broad, flat, punctate, with an elevate median longitudinal ridge; the rostrum tapers to middle, thence widens gradually, shining brown, and very slightly and finely punctate; antennae inserted above middle, the long scrobes placed at sides, the scape swollen to a knob at upper end and shorter than rest of antenna, the club large, conical. Prothorax widest medianly, tapers in front, sides rounded, a fine elevate longitudinal smooth black median line runs from the anterior to posterior margin; rest of surface rather coarsely rugose-punctate, the punctures large medianly. Elytra widest at base, constricted apically; striate punctate, the punctures large and shallow, and often confluent; with here and there small patches and spots of a fine yellowish-green pubescence. Legs punctate and pubescent. Length, 6 mm. to 7 mm.

FIG. 290. *Cryptorhynchus raja*, Steb., sp. nov. N.W. Himalaya.

Life History.

I know little on the subject of the life history of this cryptorhynchid. I first obtained a specimen of it from a pupal chamber between the bark and sapwood of a large girdled spruce-tree in June in Tehri Garhwal. Subsequently I found it in blue pine in the Bré forests in Chamba in June 1909. From a pupal chamber hollowed out in the bark and sapwood I took a dead weevil. The gallery in the bast and sapwood made by its larva is shown here. I had felled and examined a number of dead deodar and blue-pine saplings and small and large poles, which had died from some unknown cause, on either side of the upper part of the Catchment Area of the small mountain torrent which flows from here into the Ravi River. These trees had been killed by bark beetles, chiefly *Scolytus major* and *Polygraphus major*. In some cases, however, I found larval galleries of this cryptorhynchid weevil present in some abundance in the bast and sapwood of the blue pine. The round exit-holes in the thick bark showed that the beetles had already matured and left the trees.

FIG. 291.—Larval galleries of *Cryptorhynchus raja* in blue pine. *a*, position of pupation. The smaller gallery is incomplete. Chamba, North-West Himalaya. (E. P. S.)

Observations seemed to indicate that the life history is very similar to that of

C. brandisi in the *Pinus longifolia*. In view of the fact that this latter weevil is a pest of the first magnitude, the life history of this blue-pine and spruce insect, as also its abundance, requires to be carefully ascertained.

Cryptorhynchus sp.*

Habitat.—Tharrawaddy, Lower Burma; Katha, Upper Burma.

Tree Attacked.—Teak (*Tectona grandis*). Kadin Bilin Forest, Tharrawaddy; Katha.

Beetle.—Black, of usual cryptorhynchid shape, the elytra with prominent longitudinal striae down them, and punctate. Length, 13 mm.

Larva.—Whitish yellow, curved, corrugated, with a yellow-brown head. Specimen taken was half-grown.

Life History.

Towards the end of January 1905 whilst in Tharrawaddy I cut out a specimen of this weevil from its pupal chamber in the sapwood and bark of a teak-tree which had been felled in the thinnings made the previous year in the 1888 plantation. The beetle lays the eggs in the bark. The grub on hatching feeds at first in the bark and bast, and then in the sapwood, eating out the usual irregular winding gallery. When full-grown it gnaws a hole through the bark to the outside, plugs it up with a fibrous mass of bark and wood shavings, and then pupates beneath this. The specimen of the beetle found was taken in this position. It was fully mature, and hibernating until the approach of the hot season. I also found one half-grown grub in a gallery in the tree.

I obtained mature living beetles from pupal chambers in the wood of the roots of a large girdled teak-tree on 20 February 1905 in the Mohnyin Forest in Katha. This tree had been girdled about a year before. The beetles appeared to be ready to fly. It is practically certain that the insect passes through several life-cycles in the year, but the number has yet to be ascertained.

In view of the importance of this genus to the forester it is interesting to know that there are species which infest the teak.

Cryptorhynchus ? sp.

Habitat.—Changa Manga, Punjab.

Tree Attacked.—Sissu (*Dalbergia sissoo*). Changa Manga Plantation, Punjab.

Beetle.—Small. Head and prothorax dark velvety brown or black, covered with a short golden pubescence; elytra chestnut-brown, darker towards apices, with a golden pubescence. Legs brown. Length, 6 mm. to 8 mm.

Specimens of this weevil were taken from beneath the rotten bark of the main roots of a large standing green sissu-tree in the Changa Manga

* I have since determined this insect to be identical with *Cryptorhyncus brandisi*; *vide* p. 428.

Plantation. The beetles were in the tree from nine inches to a foot beneath the soil. The galleries of the grubs were in the bast and sapwood of the roots, the weevils taken being in the pupal chambers made between the bark and wood. The beetles appeared to be fully mature and ready to leave the tree when found in the third week in May.

Cryptorhynchus sp.

Habitat.—Darrang, Assam.

Tree Attacked.—India-rubber (*Ficus elastica*). Charduar Rubber Plantation, Darrang.

Beetle.—Elongate, blackish, shining. Prothorax fairly smooth, shining. Elytra coarsely punctured and occasionally slightly reddish apically. The male is either equal in size or larger than the female. Length, 7 mm. to 9 mm.

Life History.

During the first fortnight of April 1906 some investigations were made of pests infesting the Charduar Rubber plantations in the Darrang Division of Assam. The blocks where the tapping of the trees for rubber was in progress were visited. The trees are tapped by making horizontal incisions round the stem every eighteen inches to two feet up the trunk and on all branches over two feet girth. The cuts go from half to two-thirds round the trunk or branch. The milky-white fluid rubber flows out immediately the incision is made, and is caught on mats placed on the ground or against the tree-trunk beneath the cuts. This is called "mat" rubber. It only flows for about three to five minutes. The cuts are left for three days and then each is visited and the strip of rubber which has slowly oozed from the tree and congealed in the incision is pulled out. The red portion of the strip is A-class and the white B-class rubber. I inspected numerous trees during my visit, and found this cryptorhynchid weevil very plentiful, feeding at the rubber congealing in the cut. Even at cuts made but twenty-four hours previously the insect was in numbers. Many of the beetles were coupled, the curious fact being seen that the male was often larger in size than the female he paired with, which is unusual so far as my experience goes. The weevil possesses a certain power of boring, as species kept in cork-topped glass tubes gnawed a very considerable portion of the corks. The weevils paired together several times during the thirty-six to forty-eight hours they were kept in the tubes.

Baris.

Baris sp.

REFERENCE. *Ind. Mus. Notes*, V, 3, p. 110.

Habitat.—Dehra Dun, North India.

Tree Attacked.—*Terminalia belerica*. Dehra Dun (F. Gleadow).

Beetle.—I have not seen this beetle.

Life History. In June 1900 Mr. F. Gleadow, Deputy Director, Imperial Forest School, Dehra Dun, sent to the Indian Museum, Calcutta, some specimens of this insect, which he reported as infesting the fruits of *Terminalia belerica*. The small black weevils were found inside the ripe fruits. The insects were sent to M. Desbrochers des Loges, who stated that they were probably a new species of *Baris* (*Indian Museum Notes*).

CYRTOTRACHELUS.

An important genus of weevils, some species of which hollow out the growing shoots of young bamboos.

Cyrtotrachelus longipes, Fabr.

REFERENCES.—*Curculio longipes*, Fabr. *Ent. Syst.* tom. i, 395 ; Stebbing, *Depart. Notes*, i, 193 (1903).

Habitat.—Chittagong Hill Tracts. Also reported from the Cape of Good Hope.

Tree Attacked.—Muli Bamboo (*Melocanna bambusioides*). Bamboo jungles in neighbourhood of the Karnafuli River, Chittagong Hill Tracts (J. P. Gregson *et mihi*).

Description. **Beetle.**—The beetle is a large, shining, rufous-ferruginous coloured insect with a black patch on the thorax, and black longitudinal patches on the sides of the elytra, and another black longitudinal one running down the median suture of the elytra. The insect has a longish thick rostrum and long legs.

♂ Rostrum long, thick, straight, quadrangular, deeper than wide at its base, and dilated and truncate at its tip, furnished on its upper surface with two lateral rows of tubercles ; scrobes short, placed laterally. Mandibles thick. Antennae fairly long and stout ; scape arched backwards slightly ; second joint of funiculus slightly longer than others ; club fairly large, triangular, with apex at outer end ; pubescent on outer surface. Prothorax slightly longer than broad, convex, smooth and shining, rounded at sides, narrowing ventrally, and having a circular raised collar at its dorsal anterior edge which is produced laterally on either side. Elytra longer than thorax, narrowing behind, and finely but distinctly striated, the intervals between the striae being fairly broad. Looked at superficially the upper integument appears to be without punctures. Legs long, thick, and flattened ; the front ones longer than the hind, but only slightly so than the middle pair ; femora thickened ; tibiae, more especially the anterior ones, ciliated on their inner edge, and arched at their extremities and prolonged into a curved stout spine ; tarsus long, the first joint longer than the second, the third heart-shaped ; the segment of the body exposed by the elytra (pygidium) triangular, convex, and ending in a point posteriorly. Body oblong-elliptical, glabrous.

♀ much larger than ♂, with a longer rostrum. Front legs much longer than either of the hinder pairs, their tibiae being very thickly ciliated on their inner edges. Pygidium blunter at posterior extremity than in ♂. Length, ♂ $1\frac{3}{8}$ in., ♀ $1\frac{3}{4}$ in. (to end of rostrum in each case). Length of rostrum in ♂, $\frac{7}{16}$ in. ; in ♀, $\frac{1}{2}$ in. See pl. xxxviii, *c*, *d*.

Egg.—The eggs are elliptical in shape, whitish in colour, and about $\frac{3}{32}$ in. in length. See fig. *a*.

Larva.—The larva is a large, whitish, legless, curved grub, with slight fleshy tubercles on the under-side of the body. It is shown in fig. *b*.

Pupa.—The pupa is white in colour, and has the ordinary weevil shape.

Cyrtotrachelus longipes, Fabr. *a*, Eggs; *b*, larva (side view); *c*, beetle, ♂; *d*, beetle, ♀ (dorsal and side view); *e*, young bamboo shoot in which eggs are laid by the female beetle; *f*, top of bamboo shoot cut off by

Life History. The insect was found attacking the muli bamboo in the Chittagong Division by the late Mr. J. P. Gregson, Extra-Assistant Conservator of Forests, Bengal, and its life history was worked out by him in 1899. During 1900, whilst holding charge of the division, I made frequent observations on the attack, going carefully through the stages of the life history with Mr. Gregson. I was thus able to corroborate his careful and excellent observations.

The beetles appear on the wing during the latter part of May or beginning of June, at about the time the monsoon rains burst over the Chittagong Hill Tracts. They pair soon after emergence, and the female then seeks out young sprouting bamboos in which to lay her eggs, such as that figured in pl. xxxviii, *e*. Shoots attacked are always under three feet in height. The insect grasps the fleshy shoot, generally about three inches below the top, with her long front legs, and cutting an oval incision in it through the outer spathe just above an internode with her lengthy probocis, deposits two eggs at its base, covering them over with bamboo chips, which are of the same colour. These eggs, which can be seen *in situ* from the outside, have been observed to be laid towards the end of June, though as the beetles are to be found through July, and on to about the middle of August, it is not improbable that the female lays other eggs on adjacent shoots. As far as present observations show, it is, however, apparent that only one of the eggs comes to anything, as only one larva is to be found in any one attacked shoot. Dying shoots are common at the beginning of July, and numbers were examined by Mr. Gregson in 1899, and again by him and by myself in 1900. The larva, on hatching out, probably bores through the tissue horizontally until it reaches the centre of the shoot, and then invariably bores downwards, eating away the soft central portion and increasing in size at a rapid rate. It continues feeding downwards until it reaches the base of the shoot, by which time it is full-fed. The grub then retreats back up its gallery, probably enlarging the upper portions, which will be now too small for it until it reaches about the place it started from. It then cuts this portion off, gnawing it through all round below it (see pl. xxxviii, *f*). The top drops to the ground, and the now fully mature larva burrows into the soft rain-loosened earth, carrying the top or a portion of it with it, thus completely sheltering itself from atmospheric influences. Larvae in various stages of growth are to be found in the shoots in the middle of July, and they mostly become full-grown by the end of the month. About the middle of August young shoots are to be seen on all sides with their tops fallen, and in a dying or dead condition. The larva changes to the pupal state within the fallen buried end of the shoot at a depth of three to four inches, or even more, below the surface of the ground, the depth depending upon the consistency of the soil. The top of the shoot soon rots, only the harder fibres persisting (see figs. *g*, *h*). Inside this fibrous covering, which is generally caked with earth, the pupa remains during the following cold and hot seasons, emerging as a beetle at the commencement of the

ensuing rains. The warm rain moistens the ground, and thus softens the pupal "case," the fibres of which will only require wetting to crumble to dust after the heating up they have undergone during the hot months of the year, even in the shadier portions of the forest. The beetle then doubtless pushes its way out and works up through the subsoil and humus. In the case of a specimen kept I noted that the beetle, when ready to emerge, gnawed its way out of its fibrous covering, cutting a hole at one side (see fig. *g*). It will be seen that the pupa is thus safeguarded against enemies, since its covering resembles nothing so much as a decaying lump of vegetation mixed with earth mould. From the above account it becomes apparent that some ten months of the insect's life history are passed in the pupal stage, about five weeks in the imago and egg-laying stage (excluding the period during which the insect remains alive after egg-laying, which period requires further observation to ascertain definitely the number of eggs laid by the beetle), and three to four weeks in the larval or destructive stage.

Relations to the Forest.

This weevil is plentiful in the Chittagong Hill Tracts, in the bamboo jungles adjacent to the Karnafuli River. *C. longipes* has proved a most serious pest to the *Melocanna bambusioides* bamboo, killing off young shoots over a fairly wide area both in 1899 and 1900. In these years large numbers of young bamboo shoots were observed springing up in the forests at the commencement of the rains. By August some 30 to 40 per cent. on areas inspected round Kaptai and elsewhere had been killed off, in the damper localities the attack being even more severe. The infestation appeared to diminish as the moister localities near the river were left behind, and almost disappeared as one went up the slopes of the hills. I am of opinion that the severity of the attack was probably due to the great clearance made in the portions of the forest which lay in the path of the great cyclone of October 1897, which swept up into the Hill Tracts from the Bay of Bengal, destroying some valuable teak plantations near Kaptai, and laying low most of the trees it met with far up into the hills. As a result of this clearance of large tree-growth in the forest, the muli bamboo commenced to shoot up in dense masses during the rains of 1898, and this was followed by the heavy and localized attacks of the beetles in 1899 and 1900. I have no information as to whether they were continued the following year, as I was unable to visit the area in question.

Mr. Gregson stated in his note that shady places under thick growth are preferred to others. By this I understood him to mean thick *undergrowth* in moist places, not high forest. In such places the shoots undoubtedly come up thickly, and are most succulent, and as such are doubtless preferred by the beetles for egg-laying.

In the case of plantations the most obvious remedy is to collect the female beetles when egg-laying; a surer method is to dig up the pupal cases and burn them. A better remedy, however, and one which would be practicable over larger areas, would be to collect all the fallen and

obviously attacked tops, each of which contains, as we have seen, a larva, and burn them. This done carefully would do a great deal towards stamping out the attack.

Cyrtotrachelus dux, Boh.

REFERENCES.—Boh. in Schönh. *Gen. Curc.* viii, 2, p. 221; *Ind. Mus. Notes*, ii, p. 39.

Habitat.—Darjeeling, Eastern Himalaya.

Tree Attacked.—Hill Bamboo (*Dendrocalamus hamiltonii*). Darjeeling Forests (C. G. Rogers).

Beetle.—A large brown weevil, the male with very long anterior legs.

Life History.

This beetle was reported by Mr. C. G. Rogers as infesting the hill bamboo in the Darjeeling forests. Mr. Rogers noted that the insect attacked the asparagus-like tops of the bamboo, and that the beetle is often seen clinging to the shoots, which are found to be perforated by a hole from which it has emerged.

The egg is apparently laid on or in the shoot, and the grub feeds inside in a manner similar to that of *C. longipes* in the muli bamboo in the Chittagong Hill Tracts already described.

Cyrtotrachelus ? sp.

Habitat.—Tharrawaddy, Lower Burma.

Tree Attacked.—Bamboo (*Cephalostachyum pergracile*), Tharrawaddy.

Beetle.—Unknown.

Life History.

During a tour in the Tharrawaddy Division of Lower Burma, in January 1905, I noticed that the young shoots of the *Cephalostachyum pergracile* bamboo, which were plentiful in the forest, had in many cases been tunnelled into by an insect whose operations closely resembled those of *Cyrtotrachelus longipes* in the *Melocanna* bamboo in the Chittagong Hill Tracts described above.

Shoots of 3 ft. to 4 ft. in height are attacked and killed by the insect, and may be found standing upright and dead in the forest, a large round hole at one side showing where the imago had left the bamboo when mature. Inside the upper portion of the bamboo is entirely hollow, the interior having been eaten away.

The local native forest officials and villagers appeared to be well acquainted with the insect infesting this bamboo, the tunnelling work inside being done by a large yellowish-white grub. In the rains the people are said to search in the shoots for this grub and to eat it with relish, a habit common, I believe, to the inhabitants of the Chittagong Hill Tracts in the case of the *C. longipes* grubs.

I think there is every probability that this larva, which unfortunately I have not yet been able to procure, will prove to be a weevil one, and it is

possible that the insect is a species of *Cyrtotrachelus*. The local forest officials should be able to settle this point without much difficulty by collecting some infested bamboo shoots towards the latter part of the rains and keeping them until the beetles emerge.

Rhynchophorus.

The genus contains a well-known weevil pest in India.

Rhynchophorus ferrugineus, Oliv.

(*The Palm Weevil.*)

References.—Oliv. *Encycl. Méth.* v, 473; *Ent.* v, 83, p. 79, t. 2, fig. 16*d*; *Ind. Mus. Notes*, ii, 8.

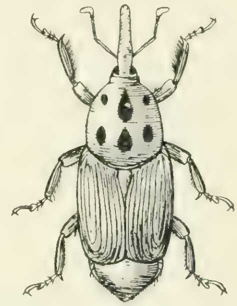


Fig. 292.
The Palm Weevil (*Rhynchophorus ferrugineus*, Oliv.). India.

Habitat.—India and Ceylon.

Trees Attacked.—Coco-nut (*Cocos nucifera*); Toddy Palm (*Phoenix sylvestris*); Date Palm (*Phoenix dactylifera*).

Description.

Beetle.—A large, stout, elongate, red-brown, shining weevil, furnished with an elongate proboscis, longer in female than in male, on which the elbowed antennae are set on the basal half; the thorax is convex, smooth, with five black spots, narrowed in front, with curved sides and truncate base; the scutellum is large triangular; the elytra small, truncate at base, leaving exposed a large broad pygidium longitudinally striate-punctate. Length, 33 mm. to 34 mm. (See figs. 264, 292).

Larva.—White, fleshy, legless, the body thickest across the middle, corrugated, bluntly tapering posteriorly. The thoracic segments scarcely wider than the head, which is brown. Length, 36 mm. (fig. 265).

Fig. 293.
Cocoon of the Palm Weevil.

Cocoon.—The cocoon is blunt-elliptical, strongly made of twisted-up palm fibres. It varies in size, but is roughly about 50 mm. long by 22 mm. broad (fig. 293).

Pupa.—Elongate, whitish yellow, of the characteristic curculionid type (fig. 265).

Life History.

The life history of this weevil is well known throughout the area of its distribution and depredations in the East. In India it is a serious pest wherever the coco-nut and toddy palms are grown, whether in Bombay, Bengal and Assam, Madras or Burma. The beetle lays its eggs on the tree near the base of the sheaths of the leaves, searching for abrasions and wounds made on the tree during storms or by other insects such as the rhinoceros beetle (*Oryctes*, p. 87), or, perhaps the most fruitful source of injury, because the commonest, at the cuts and wounds made on the tree when collecting the nuts or, in the case of

the toddy palm, when extracting the toddy liquor from the tree. The grubs on hatching out tunnel through into the stem and gradually eat out an ever widening and lengthening gallery which penetrates into the heart of the stem. When the insect is infesting the trees in numbers these tunnels intersect and remove the bulk of the growing parts of the tree, which is thus killed.

The generations of the insect would appear to overlap even in the North of India, for throughout the country the insect is to be found in most months of the year (save the winter) in all the stages of larva, pupa, and beetle. For instance, in *Indian Museum Notes* it is reported that Mr. Ridley found the insect in all stages in date-palms in the Lucknow Horticultural Gardens in April 1890, whilst it was reported the same year by Mr. Gollan as infesting date-palms in the Saharampur Botanical Gardens. In each case the insect had killed several trees.

The methods of combating attacks of this pest are similar to those already detailed on p. 89 for the rhinoceros beetle, whose attacks are often accompanied by this weevil.

Cercidocerus.

Cercidocerus lateralis, Fährs.

Reference.—Fährs. Schh. *Gen. Curc.* viii, 2, p. 232.

Habitat.—South Coimbatore, Madras. Also reported from Java.

Tree Attacked.—*Dalbergia paniculata.* Mount Stuart, Anamalai Hills, South Coimbatore.

Description.

Beetle.—♂ An elongate brown weevil, easily recognizable by the peculiar antennal club; the funiculus terminates in an appendage which has the appearance of, and is inserted in the manner of the anther of, the stamen of a liliaceous plant, i.e. it has the appearance of a square-headed polo stick. The proboscis is elongate, and capable of a considerable amount of boring work. The elytra leave two segments of the body exposed to view. Length, 10 mm. to 12 mm.

♀ Differs from male in the antenna terminating in a mere knob instead of the "anther"-shaped structure. Only one segment of the abdomen is left exposed by the elytra.

Life History.

I took specimens of this curious weevil on *Dalbergia paniculata* saplings, on the leaves of which it was feeding. The insects were taken at the end of July 1902, in the Mount Stuart forests in South Coimbatore. The weevil was not abundant, and I am unable to say whether the defoliation committed is serious. The beetles were pairing at the time of capture. I kept a male and female for over a week alive in a tube without food. During this period they bored half an inch through the cork, and paired several times. I do not know where the grubs live.

Odoiporus.

Odoiporus longicollis, Oliv.

References.—*Sphenophorus planipennis*, Gyll. in Schönh. *Gen. Curc.* iv, p. 911; *Ind. Mus. Notes*, ii, p. 151.

Habitat.—Ceylon. I took the beetle in Sikkim.

Tree Attacked.—Coco-nut (*Cocos nucifera*).

Description.

Beetle.—Elongate, rather narrow. Light brown, darker beneath; head and anterior margin of prothorax black. Head small, rostrum long, antennae inserted near base. Prothorax longer than wide; disk flat, smooth, with a few scattered punctures, denser laterally. Elytra strongly striate-punctate; disk flat, apex truncate, the apices separately rounded and leaving exposed a large punctate pygidium, constricted posteriorly. Under-surface smooth, shining, punctures scattered. Length, 13 mm. to 22 mm.

This beetle was reported by Nietner to injure the coconut-tree in Ceylon. I do not know upon what it feeds in Sikkim.

Odoiporus sp.

Reference.—Stebbing, *Injur. Ins. Ind. For.* p. 59 (1899).

Habitat.—Sikkim, Eastern Himalaya.

Tree Attacked.—Preng Bamboo (*Arundinaria aristata*). Sikkim, 5,500 ft.

Beetle.—A pretty elongate rosy-pink coloured weevil, the elytra leaving exposed the pygidium.

Life History.

I first took specimens of this weevil towards the end of April 1896, at an elevation of about 5,500 ft., in Sikkim. The beetles were found clinging to the stems of the preng bamboo, which is found in the forests of this locality. The shoots of stems subsequently examined were found to be eaten out by weevil grubs, the beetle when mature boring through the stem to escape.

The hillmen informed me that considerable damage was done to bamboos in this way by an insect which had all the appearance of being this particular weevil.

The insect proved new to the Indian Museum collections.

Calandra.

Calandra sculpturata, Gyll.

(*The Acorn Weevil.*)

References.—Gyll. Schönh. *Gen. Curc.* iv. p. 94 (1838); B. O. Coventry, *Ind. Forester*, xxviii p. 388 (1902).

Habitat.—North West Himalaya.

Tree Attacked.—Ban Oak (*Quercus incana*). Mussoorie (B. O. Coventry).

Beetle.—Has the regular weevil shape. On first emerging from the pupal state it is red in colour, but soon changes to a dark red-brown. The whole surface is covered with small punctures. The proboscis is curved and about one-sixteenth of an inch long. The antennae are elbowed, and spring from near the base of proboscis. Thorax covered with punctures, irregularly scattered. The tibiae of the legs are ribbed and bear a hooped spine, and the punctures are in longitudinal rows. The elytra do not quite cover the abdomen, and have broadly rounded ends. They are ribbed, and the punctures are arranged in longitudinal rows, about fourteen rows on each elytron. The elytra are about half the length of the body. Length, $\frac{3}{16}$ in. exclusive of proboscis ; proboscis slightly over $\frac{1}{16}$ in. In fig. 294, *a*, *a'*, *b*, *c*, show the larva, pupa, and imago of this weevil, and also an attacked acorn.

Description.

Larva.—A small, white, short, stunted, legless grub, almost as broad in the centre as long, with a small pale-brown head. Length, $\frac{3}{16}$ in.

Pupa.—White, of usual weevil type, and about same length as larva.

Life History.

This weevil first begins to emerge from the acorns about the middle of June, and continues to do so until the end of the month. Mr. B. O. Coventry, I.F.S., who first studied its life history, is of opinion that it probably immediately lays eggs in the young new acorns from the preceding year's flowers, which are present on the trees at the time of emergence of the insect, and that a second generation of the weevil appears in the autumn. This may prove to be the case, since the acorns ripen between August and October, but remain in the tree through the ensuing winter. The pupal stage in the spring only lasts a few days.

The eggs are evidently laid on the acorns, the weevil not improbably drilling a hole into the fruit with its proboscis and placing them in it. As many as six or seven beetles have been obtained from one nut.

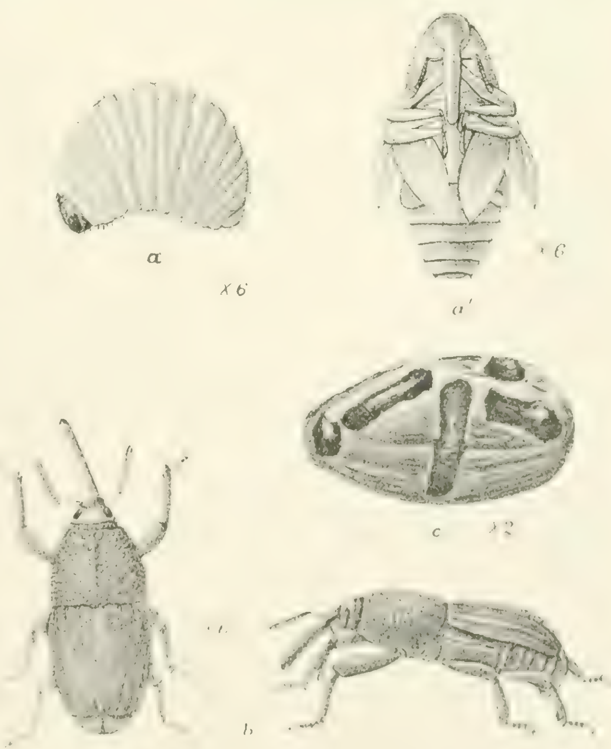


FIG. 294.—*Calandra sculpturata*, Gyll. *a*, larva ; *a'*, pupa ; *b*, beetle ; *c*, attacked acorn. Mussoorie, North-West Himalaya.

The larvae feed inside, reducing the kernel to a powdery mass, no external opening being visible in the outer skin of the fruit. Mr. Coventry thus describes the pupation : " On removing this shell or skin the pupae are seen lying each in a separate compartment of its own. The kernel of the acorn, though reduced to a fine powdery condition, is still firm and fills the shell, so that when this latter is removed the inside appears solid, with the pupae lying in little compartments on its surface (see fig. *c*). With slight pressure, however, it falls to pieces, and it is seen that each compartment is really a small cradle-like cocoon covered above by the shell of the acorn." When ready to emerge a hole is bored through the shell to the outside—presumably by the first beetle to mature, since all the others issue by the same orifice. The acorns fall to the ground during the attack about the time the larvae become full-fed. The beetle is said to be very lively, but feigns death when disturbed.

Mr. Coventry took this weevil in ban-oak acorns at Mussoorie, in the North-West Himalaya, in June 1902.

Relations to the Forest.

This beetle is a most serious pest to the acorns of the ban oak (*Quercus incana*), in which it lays its eggs, the larvae burrowing and feeding in and destroying the fruits. Mr. Coventry states that the insect is largely responsible for the absence of natural regeneration of this tree in the Mussoorie Hills. He wrote as follows on this subject: " On 11 June 1902 I collected a large number of acorns of *Q. incana* at Mussoorie with the object of ascertaining what proportion of them was sound, as I could not account for the general absence of natural regeneration from seed of this species. The result of the investigation showed that about 80 per cent. were unsound. Some of the acorns were collected from trees, and others from the ground where they had quite recently fallen. The unsoundness of the acorns was found to be due to the attack of a weevil beetle."

Protection and Remedies.

The best protective measure to take for pests of this nature is to collect and burn, when at all feasible, the whole seed crop during a bad attack. If this were done in patches of forest only it would have the effect of greatly diminishing the numbers of the weevils on those areas, and the next crop of acorns would thus be attacked by a very much smaller number of beetles. Children could be put on at small cost to do the collection work over certain areas, and this work should be begun as soon as the acorns commence to drop.

It is a point of considerable importance to ascertain whether the weevil also infests the acorns of the moru and kharshu oaks growing in this region of the Himalaya. Also what predaceous and parasitic foes attack it.

SIPALUS.

Sipalus hypocrita, Boh.

REFERENCE.—Boh. Schönh. *Gen. Curc.* viii, 209.

Habitat.—Salween River, Tenasserim.

Tree Attacked.—*Dalbergia* sp. (*cultrata ?*). Kowloon Island, Salween River.

Beetle.—A large weevil with a thick heavy body. Brown or greyish brown, mottled, with three longitudinal rows of black spots on elytra alternating with yellowish ones. Head small, with a very long rostrum, curved downwards and inwards; the antennae inserted on the basal half, the scape fitting into a deep scrobe on under-surface of rostrum. Prothorax widest medianly, of considerable size, disk flat and very roughly corrugated, as also sides, which are rounded. Elytra wider than prothorax, disk rather flat, apical portion depressed, sides straight to apical third, thence constricted to apices; striate-punctate, the punctures very large and shallow. Under-surface punctate and imbricate, the abdomen black, smooth, with a short whitish or yellowish pubescence. Length, 19 mm. to 25 mm.

Description.

FIG. 295.
Sipalus hypocrita, Boh.
Tenasserim.

Life History.

From a pupal chamber in the sapwood of a large standing *Dalbergia* tree, possibly *cultrata*, I took a living specimen of this weevil. The beetle was fully mature and ready to issue. Traces of a large larval gallery were visible on the outer sapwood of the tree. The insect was taken on 9 March 1905. Other insects which had infested this tree were the elater beetle (*Alaus*, p. 226), and a wood-boring *Xylocopa*.

Undetermined Weevil.

REFERENCES.—*Ind. Mus. Notes*, ii, 151; *Indian Forester*, vol. xxxi, 76 (1905).

Habitat.—Western Duars; Nilumbur, South Malabar, Madras.

Tree Attacked.—Mahogany (*Swietenia mahogani*). Western Duars; Nilumbur.

Beetle.—Unknown.

Larva.—A fat, white, curved, legless grub, thickest in middle; head horny dorsally, orange-brown, with scattered yellow hairs on it; mouth-parts black. Body tuberculate, the tubercles bearing a few white hairs on them.

Life History.

The grub lives in the juicy bark and sapwood of the mahogany. The eggs are laid on the bark or in small incisions made in it with the proboscis. The grub on hatching at first feeds in the bast layer only, subsequently going further in, and grooving out an irregular-shaped gallery in the bast and sapwood. The irritation set up by the boring action of the grub causes the tree to

answer with an outflow of resinous matter, which, together with the excreted woody particles, fills the gallery, and also exudes from the aeration holes, which the grub apparently eats to the outside of the tree to admit air to its gallery. This resin drips down the outer bark in narrow runnels, congealing into a sticky mass of considerable size round the orifice, and the presence of these blobs makes an attacked tree easily recognizable. The weevil oviposits either on the main stem or the larger branches of living trees, the one thing needful being the presence of old bark on the tree. In badly infested trees the runlets of resin can be seen in vertical rows and lines on the bark from near the top to the base of the tree. Evidence is also apparent of old attacks, as the borings of the grubs appear to result in swellings and knotty outgrowths on the stem and branches.

I found larvae at work in green mahogany-trees in the Aravallikavu Plantation at Nilumbur, in South Malabar, towards the end of August 1902, but failed to breed out beetles from them.

Larvae which may be identical with the Madras ones were sent to the Indian Museum some years ago, with the report that they attacked mahogany-trees in the Western Duars.

Undetermined Seed-eating Weevils.

In Sál Seed.—A minute undetermined weevil was said by Mr. Thompson to have been very destructive to sál seed in the United Provinces in the year 1863. Entire seed crops are said to have been destroyed in that year. The weevil grubs were probably assisted by the caterpillars of the moths mentioned on p. 17.

In Oaks—Quercus pachyphylla and *Q. lamellosa.*—A small undetermined weevil was reported by Mr. C. G. Rogers to have destroyed 90 per cent. of the seed of the valuable oak *Q. pachyphylla* in the Darjeeling forests. Only grubs were obtained.

In January 1896 I found that about 85 per cent. of the seed of the oak *Q. lamellosa* trees in the forests of British Sikkim was attacked and ruined by weevil grubs. Unfortunately I failed to obtain mature beetles.

COSSONINAE.

I follow Lacordaire, Ganglbauer, Sharp, and Marshall in placing the Cossoninae as a division of the Curculionidae. At the same time the group, from the forest point of view, appears to have characteristics which require some description.

The Cossoninae are small wood-boring beetles, usually black in colour. They approximate in characters to the Curculionidae and the Scolytidae, resembling to some extent the genus *Hylastes*, but differing in having a more elongate appearance and a longer proboscis.

So far as present knowledge of the Indian forest species extends they appear to confine themselves entirely to tunnelling into wood for ovipositing purposes, and frequent both broad-leaved trees in the plains and conifers in

the Himalaya. The beetles seem to prefer wood which has partially dried and lost a considerable portion of its sap. To mention a few of the trees in which I have taken species of this family, members are known to infest the deodar, blue pine, spruce, and *Pinus longifolia* in the Himalaya; the sál, pyinkadu, *Ficus elastica*, *Morus laevigata*, and *Dendrocalamus strictus* in the plains.

Beetle. The beetle looks, as I have said, like a cross between a weevil and a scolytid, having a generally narrow elongate shape with a pronounced straight beak, the colour black and usually shining, with elytra narrowing apically, the apices often being elevated, forming a channel; the elytra may be striate, and set with prominent rounded raised rows of shining points.

Larva.—The grub is white, rather curved, and somewhat corrugated.

To a certain extent the Cossoninae must be considered as of some importance as wood-borers. Further study is, however, required before it is possible to assign to them their real position in the economy of the forest.

Rhyncholus.

Rhyncholus himalayensis, Stebbing, sp. nov.

REFERENCE.—Stebbing, *Depart. Notes* (*Rhyncholus* sp.), i, 198 (1903).

Habitat.—North-West Himalaya.

Trees Attacked.—Blue Pine (*Pinus excelsa*), Spruce (*Picea morinda*), Deodar (*Cedrus deodara*). Jaunsar, Simla, Naini Tal, Chamba.

Beetle.—Long, narrow, black, shining, with elbowed antennae, the club of antenna pale yellow, and tibiae and tarsus rufous brown with reddish-yellow hairs. Head large, very shining, punctate; rostrum not longer than head, stout, cylindrical, slightly depressed downwards; scrobes narrow, starting near centre of rostrum, and oblique. Antennae start from lower half of rostrum, short, fairly stout; scape club-shaped at upper end; funiculus seven-jointed, first joint long, second to seventh very short, increasing in size upwards; club smallish, oblong-oval, first joint long and reversed-cone-shaped; others short, spongy, pale yellow in colour. Eyes medium-sized, oval. Prothorax long, slightly conical and rounded on sides, rounded at upper and truncate at basal ends, with a transverse depression just below the upper edge; coarsely rugose-punctate. Scutellum very small. Elytra long, cylindrical, rather flattened, slightly wider than prothorax behind, depressed behind, and projecting down laterally below the abdomen towards their extremities on each side, the apex constricted, apices with a crescent-shaped interval between them, the points of the elytra forming the outer horns of the crescent. The elytra bulge laterally on either side into a small projecting point just before the depression commences. Legs short, femora thickened in middle and flat, arched beneath; tibiae straight, flattened, and toothed

Description.

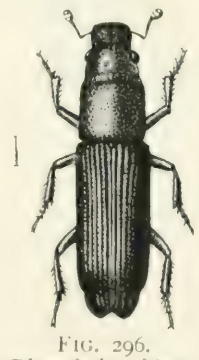


FIG. 296.
Rhyncholus himalayensis, Steb., sp. nov. North-West Himalaya.

at their base ; tarsus short, filiform ; third joint not longer than the others and not bilobed ; fourth long, with small claws. Intercoxal joint large and rounded anteriorly. Body long parallel, and more or less cylindrical, thickening to a certain extent posteriorly. Rostrum, head, prothorax, and body above and below densely punctured, the punctures being lighter on dorsal surface of head. Elytra channelled by longitudinal deep striae, and punctured. Length, 3.9 mm. to 4.8 mm.

Life History.

This beetle is a wood-borer, and appears on the wing in the spring about the second week in May, from which date it may be found till the end of June in considerable quantities boring into the wood of blue pine and spruce to lay its eggs. The resulting beetles form the first generation of the year. The beetles attack the trees in swarms, and may be found during these months either in or beneath the bark, or on or in the sapwood. They bore either horizontally or at an angle into the dead bark of the standing tree, and on reaching the sapwood either continue their burrow into it or more usually move about for a time between the sapwood and bark, cutting a long groove in the latter before going into the wood. Having selected a suitable spot, they then bore into the sapwood, usually at an angle. This tunnel is carried for about an inch or less into the wood, and the insect then turns and burrows up the long axis of the tree for as much as a couple of inches. The eggs appear to be laid at the end of this long gallery. The latter is not always straight, but may bend yet again and go farther into the solid wood. The figure shows a curved boring of this beetle.

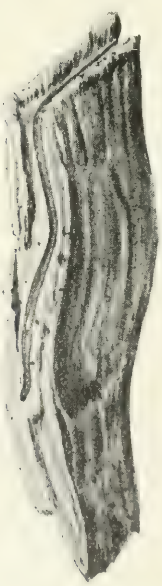


FIG. 297.
Piece of blue-pine wood showing a gallery of *Rhyncholus himalayensis*, Steb.

There is at least one other generation in the year, as I have taken the beetles tunnelling into trees at the end of September and in the first weeks in October.

Relations to the Forest.

I first discovered this insect at Kathian in Jaunsar in 1901 in dead blue-pine. The following year I took it plentifully in blue-pine and spruce at elevations between 5,500 ft. and 7,500 ft. in the same locality. In later years I took the insect in the Simla and Naini Tal divisions, and also in Chamba.

The information on the life history of this beetle is at present too meagre to enable its relation to the trees it attacks to be definitely stated. That it is capable of swarming in large numbers has been ascertained, and the value of the wood attacked is considerably diminished, so far at least as its external appearance goes, by the tunnelling work of the insect. It is often to be found in company with *Hylastes himalayensis* (p. 473).

Platysoma rimae, Lewis (p. 105).—This insect is predaceous upon the *Rhyncholus*. It is described on p. 576.

Predaceous Insects.

Paromalus sp. nov. (p. 107).—Predaceous upon the *Rhyncholus*.

Beetle.—A small, compact, elliptical, shining black beetle, chiefly remarkable for having a number of spiny hairs projecting from the extremity of the ventral surface of the abdomen. Head not as wide as thorax, with a prominent depression on either side commencing in outer upper angle and sloping backwards and inwards to lower third, but not meeting the hind margin. Thorax with front margin deeply concave. A longitudinal depression on each side of the median line, the surface with prominent and fairly numerous punctures. Elytra nearly cover the whole body, only two narrow segments of the abdomen being visible behind dorsally; the surfaces densely punctured, the punctures, however, less numerous on either side of the median line. Under-surface black, abdominal segments reddish, with numerous reddish projecting spiny hairs. Legs reddish, with four teeth on outer edge of the front tibia. Length, 3.2 mm.

Life History, etc.—This beetle is to be found in the mature state in the middle of June at about 7,000 ft. in the North-West Himalaya. It was discovered beneath spruce bark in company with this wood-borer and the scolytid *Hylastes himalayensis*, and it is probable that it preys upon them or their larvae. It was also found some days later beneath blue-pine bark amongst a large number of different bark- and wood-boring larvae. It is an active little histerid with a quick walk.

FIG. 298.
Paromalus sp. nov.
× 8.
North-West Himalaya.

Rhyncholus sp.

Habitat.—North-West Himalaya.

Tree Attacked.—*Pinus longifolia*. Chaubattia, Naini Tal, Chamba.

Beetle.—Resembles the last. Elongate, narrow, parallel. Shining black. Head with a well-marked rostrum. Prothorax long, shining, and smooth. Elytra elongate, narrow, wider than prothorax behind, depressed at apex; strongly punctate and striate longitudinally, the striae deep. Length, 4.7 mm.

Life History.

This beetle first makes its appearance in the year early in April. A second generation appears at the beginning of June, and probably other generations later on in the year. A tunnel is bored by one of the beetles, probably the male, down into the bark and outer sapwood of the *Pinus longifolia*. A female joins the male here, is fertilized, and then cuts out a curving tunnel which penetrates down into the wood at an angle.

Niponius canalicollis (p. 103) is predaceous upon this *Rhyncholus*. It is described on p. 507.

Conarthrus.

Conarthrus affinis, Woll.

Habitat.—South Coimbatore, Madras.

Tree Attacked.—*Dendrocalamus strictus.* Mount Stuart, South Coimbatore.

Fig. 299. *Conarthrus affinis*, Woll. South Coimbatore.

Description.

Beetle.—Elongate, narrow; shining black, punctate, legs rufous brown. Head prominent, about same length as rostrum, very shining punctate; rostrum stout, flattened, broadest anteriorly, where it swells into a blunt knob; finely punctate; the scrobes commence slightly above centre and run backwards obliquely to near the eye; antennae inserted near base of anterior swelling. Prothorax shorter than head and rostrum together, truncate at upper and basal ends, widest just above base, sides rounded, rather coarsely punctate. Elytra elongate, parallel, but slightly wider than prothorax at base, constricted and depressed apically, the sides bent downwards, covering a portion of the lower surface of abdomen; strongly striate-punctate. Length, 5.3 mm.

Life History.

This insect tunnels into the nodes of the *Dendrocalamus* bamboo for ovipositing purposes. A generation was discovered thus occupied in the South Coimbatore forests at the end of July 1902. The beetle tunnels into the node, and then carries the tunnel either up or down in the wall of the bamboo. In some instances the tunnels are carried horizontally round the circumference of the wall. The tunnels are long, the eggs being deposited amidst some wood-powder near the bottom of the tunnel. The beetle attacks half-dead and dead bamboos, riddling the wood to powder when the insect is in numbers.

Conarthrus jansoni, Woll.

Habitat.—Goalpara, Assam.

Tree Attacked.—Sál (*Shorea robusta*). Anguri Block, and Kachugaon, Goalpara.

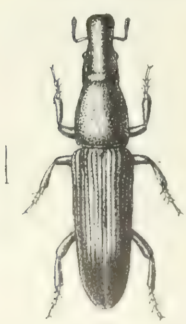


Fig. 300. *Conarthrus jansoni*, Woll. Goalpara, Assam.

Description.

Beetle.—Elongate, narrow, parallel. Shining black, punctate. The rostrum is long, swollen anteriorly; scrobes commence well forward, are short and deep, and do not extend backwards to the eye. Prothorax elongate, convex, broadest at middle, the sides curved; uniformly and finely punctate. Elytra as wide as broadest part of prothorax, constricted and depressed apically, leaving a small portion of the pygidium disclosed. Strongly striate-punctate. Under-surface black, shining, punctate. Legs ferruginous brown. Length, 6 mm. to 6.3 mm.

A number of specimens of this beetle were found tunnelling into felled and partially dry sál-trees at the end of April 1906. The insects were tunnelling

down into the sapwood to oviposit. The egg galleries were in no case complete, but after entering the sapwood the female curved her tunnel to one side or the other. I do not know whether the tunnels reach the heart-wood. I took the beetle subsequently plentifully at Kachugaon in Goalpara in the middle of May of the same year in the timbers of a bungalow built of sál-wood. It had evidently issued to oviposit in fresh wood.

Himatium.

Himatium asperum, Marshall, sp. nov.

REFERENCE.—Marshall, *Ann. Mag. Nat. Hist.* Aug. (p. 189) 1913.

Habitat.—Goalpara, Assam.

Tree Attacked.—Sál (*Shorea robusta*). Kachugaon, Goalpara.

Description.

Beetle.—Small; highly punctate, uniform red-brown, with stout pale setae. Elytra with the pubescence arranged in longitudinal rows on the striae. Under-surface moderately shining brown to brownish black, covered with a sparse golden stiff pubescence. Head very convex, strongly punctate, the rostrum short and thick; about twice as long as broad, straight, almost cylindrical, mostly covered with coarse and longitudinally confluent punctures. Antennae brown, the club pubescent. Prothorax nearly half as long again as broad, widest near base, gradually narrowed anteriorly, with a deep constriction near apex; coarsely reticulate-punctate. Elytra very strongly striate-punctate, the punctures large; the intervals not broader than the striae, and each bearing a row of stout recumbent overlapping setae, the alternate intervals also with a row of erect scale-like setae. Under-surface punctate. Length, 2.5 mm. to 3 mm.

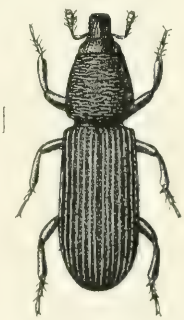


FIG. 301.
Himatium asperum, Mshl., sp. nov. Goalpara, Assam.

Life History.

Some specimens of this small beetle were taken in the middle of May from beneath the bark of a large green sál-tree felled in the Kachugaon forests three days before. The insects were taken from the upper part of the stem, which had commenced to die, apparently from strangulation by creepers, the upward flow of sap being much reduced. The beetles were ovipositing in the sapwood and inner bark.

Undetermined Cossoninae.

I have not been able to identify the following three species of this group:—

Rhyncholus ? sp.

Habitat.—Tharrawaddy, Lower Burma.

Tree Attacked.—Pyinkadu (*Xylia dolabriformis*). Kadin Bilin Forest, Tharrawaddy.

Beetle.—Narrow, elongate; dull black.

Specimens of this beetle were taken in the dry sapwood of a dead pyinkadu-tree at the end of January 1905. The insect tunnels through the bark until it reaches the sapwood, which it penetrates from an eighth to a quarter of an inch, and then carries its tunnel at right angles to the former direction. This latter tunnel is sometimes broad and somewhat elliptical in shape, of greater diameter than the beetle, the bottom being filled with powdered wood-dust, in which it is possible that the eggs are laid, or pairing may take place here. In other cases examined the tunnel parallel to the long axis of the wood was of the same diameter as the beetle. The beetle was fairly plentiful in trees examined, but appeared to infest only the sapwood.

Life History.

Rhyncholus ? sp.

Habitat.—Katha, Upper Burma.

Tree Attacked.—*Morus laevigata*. Mohnyin Forest, Katha.

I cut a specimen of a *Rhyncholus* beetle from a tunnel in the sapwood of a felled *Morus laevigata* tree in the third week in February. The beetle was mature, and evidently ready to issue from the tree as soon as the weather got warmer.

Rhyncholus ? sp.

Habitat.—Darrang, Assam.

Tree Attacked.—India-rubber (*Ficus elastica*). Charduar Rubber Plantation, Darrang.

I took some specimens of a *Rhyncholus* beetle from the wood of drying felled rubber-trees in the Charduar Rubber Plantation early in April 1906. The beetles were ovipositing. The females eat out long curving tunnels down into the wood of the tree, the eggs being laid at the bottom of the tunnel. In some cases larvae had already hatched from the eggs.

Life History.

CHAPTER XX.

RHYNCHOPHORA (*continued*)—Family SCOLYTIDAE (IPIDAE).

(*Bark-borers.*)

The Scolytidae, or bark-borers (so called because a number of the members of the family bore through the bark to oviposit inside the tree) probably include some of the worst pests the forester has to cope with. And the insects are all the more difficult to deal with owing to their small size, an eighth of an inch or less being the length of many of these minute beetles. The forester has therefore no chance of making an acquaintance with this form of insect life in the easy manner in which he may learn to distinguish the longicorn beetles. Occasional specimens do, it is true, enter the bungalow at night, but it requires a certain knowledge of insects to be able to pick out a bark-beetle on the wall or cloth from the variety of minute forms which will be crawling about round him. And in India the commoner forms of Scolytidae which are pests in the forests are mostly of small size. Some years ago I submitted a small collection of Indian specimens to Mr. Walter J. Blandford, known to many an Indian forester as Lecturer in Entomology at Coopers Hill, and himself a great authority on this family. Mr. Blandford's remark on the collection was that "it is the most uninteresting, and contains a majority of the most obscure minute forms, of any collection I have had sent to me." Our national collections in the British Museum contained but few of the Indian forms now known to be of considerable, sometimes of first-class, importance economically. In fact many of these forms proved to be undescribed species, the presence of which in India (or closely allied species) was foreshadowed by the collections made by Mr. George Lewis in Japan and described by Mr. Blandford in the *Transactions of the Entomological Society.**

The position of affairs in India having been recognized, a close study of the family became an imperative necessity, if progress was to be made in the protection of the forests from a grave source of danger, and this study has been carried on unremittingly during the past twenty years.

As we shall see, although these insects are not commonly met with on the wing, they are easily found when the forester has learnt where to look for them, and when this knowledge has been assimilated together with the life history of the local individual bark-borer pest or pests, it should, under ordinary circumstances, be quite feasible for the forester to keep these insects within bounds.

* Blandford, The Rhynchophorous Coleoptera of Japan. Part iii, Scolytidae. *Trans. Ent. Soc. Lond.* pt. i, 53 (1894).

In spite of its minute size, the bark beetle, in the more ordinary forms, is easily recognizable once the characteristics of the build of the insect have been grasped.

Beetle.

The beetle is usually cylindrical in shape, though some specimens are spherical, as e.g. *Sphaerotrypes* (cf. fig. 20), and brown or black in colour, at times yellow or grey, owing to being clothed with a dense pubescence of this colour. The most characteristic portion of the insect, and the one which easily distinguishes it from all other insects, is the antenna. The head is small, prolonged either into a very short rostrum or not prolonged at all, and is often entirely concealed beneath the projecting prothorax, which forms a hood over it, as in the case of many Bostrychidae. The mandibles are curved, or slightly toothed, and stout. The antenna is short, elbowed, and inserted between the eyes, these latter being often hollowed out to allow of the insertion of the antenna; or the eye may be in two pieces with the antenna inserted between them. The antenna does not fold back into a groove as in the case of Curculionidae, but when the insect is at rest is held back against the side of the head. The antenna consists of three chief parts: (1) The portion joining the head, which forms the lower part of the elbow, consists of one long joint, termed the "scape," and is held more or less horizontally when the antenna is in motion; (2) a portion consisting of a number of joints which may be as many as seven or may be fewer, termed the "funiculus"; (3) a knob-shaped portion which varies in shape, is either solid or may have transverse divisions in it, and is termed the "club." The club is inserted on to the top joint of the funiculus, and with it forms the upper part of the elbow, which is usually more or less vertical, and at right angles to the scape. Fig. 303 shows this antenna with a five-jointed funiculus and a club of four partitions. The antenna is of considerable importance in the family, since the classification of the various divisions is based on differences in its structure. The prothorax is generally very long, often forming half the total length

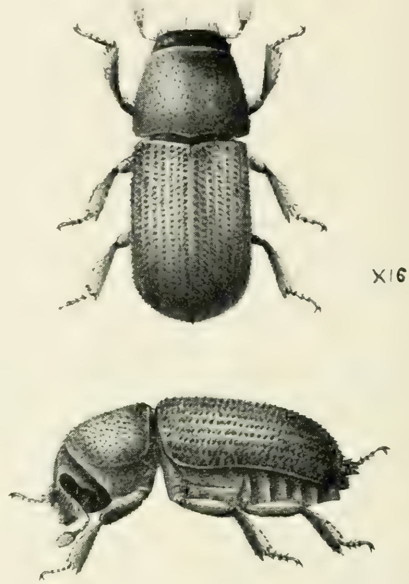


FIG. 302.
A Scolytid Beetle (*Polygraphus*).
North-West Himalaya.

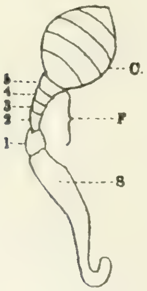


FIG. 303.
Scolytid Antenna.
S, scape; F, funiculus of five joints; C, club.

of the insect. It varies in shape, having a triangular appearance in the spherical forms. It may be smooth and shining, or densely pitted or rugose. The elytra cover the whole of the abdomen, in some instances are very convex, and are often sharply declivous towards their apices, the declivous portions having at times a scalloped appearance owing to the presence of marginal teeth varying in size. The elytral surface may be smooth and shining, or striate and punctate or rugose. The upper surface is often set more or less densely with coarse spiny hairs, which appear in tufts on the front of head (*Polygraphus trenchi*, pl. xlviii, fig. 1), or densely on sides of elytra and in the apical declivity. The under-surface is also often densely hairy, the pubescence being usually less coarse in structure.

The legs are short, many of the species walking in a feeble manner on smooth surfaces, although they are able to move rapidly in their tunnels in the bark and bast. The femora are toothed, the tibiae are flattened laterally, and in the majority the front tibia is spined or toothed on its

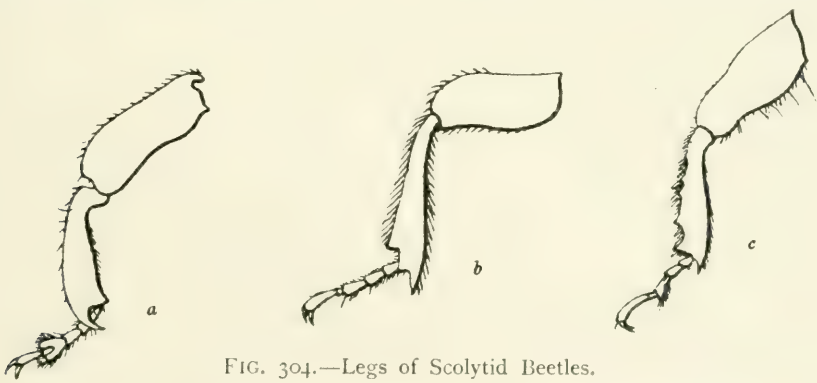


FIG. 304.—Legs of Scolytid Beetles.

outer edge, a point used in the classification; these tibiae are used by the beetle to shovel wood-dust out of the tunnel. The tarsi are four-jointed (really five-jointed, one joint being very short), and the third tarsal joint may or may not be bilobed. The tarsus ends in a double claw.

The antenna and four-jointed tarsi easily distinguish the Scolytidae from the Bostrychidae.

Larva.

The larvae are small, soft, white or yellowish-white grubs, which are almost always curved in the case of bark- and bast-feeding forms, or very convex above and flat beneath (*Sphaerotrypes*, fig. 315), whereas in the case of the beetles which tunnel into the solid wood to oviposit the larvae are usually almost straight. They are invariably legless, are crinkled and corrugated, tapering in the posterior segments, broadest across the thoracic segments,

FIG. 305.—Scolytus Larva.

with a small, usually yellow head, and black or brown strong mandibles. The larva is easily distinguished from the bostrychid larva owing to its being legless.

Pupa.

The pupa is white or yellowish-white in colour, soft, blunt elliptical, circular, or elongate in the wood-boring forms. The head is hidden beneath the projecting prothorax, and the legs and wing-cases pressed close to the chest. When the pupa has gradually assumed the form of the future beetle, the latter remains for a varying period in the pupal chamber in a resting stage. At this period the insect will be usually light yellow or brown in colour, and is still immature for identification purposes. On various occasions Scolytidae sent from different parts of the world have been taken from the pupal chamber in this resting stage, with the result that their determination has been impossible. The colour gradually changes from the light tints to darker browns or blacks, whilst at the same time the outer parts solidify, and the insect is then ready to leave the pupal chamber. In many cases it quits the tree by tunnelling straight through the layers of wood and bark between the pupal chamber and the outer air.

Habits of the Family.

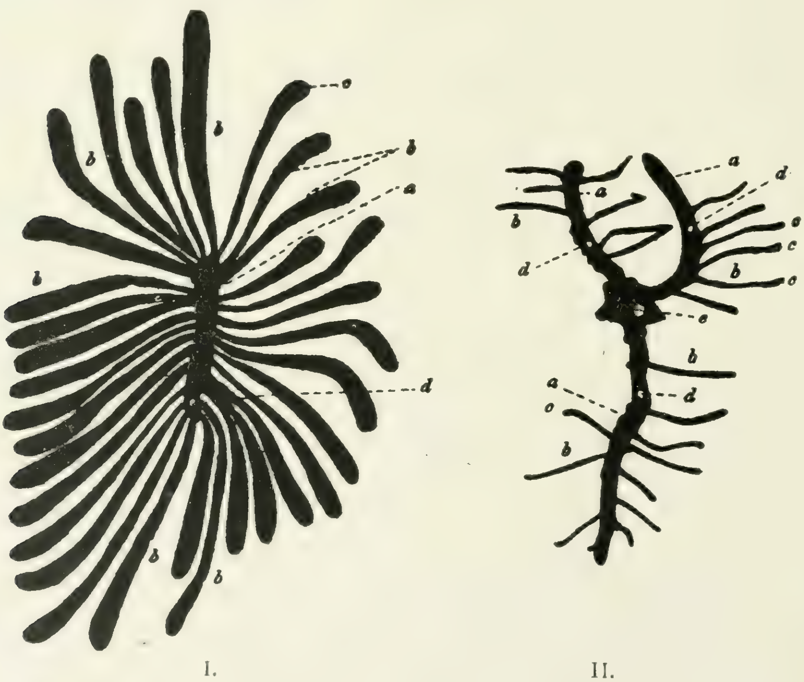
This family is peculiarly a forest-living one, the greater bulk of the species probably ovipositing in forest trees or woody plants, either in the bark or bast, or in the sapwood or heart-wood. The mature beetles appear on the wing for short periods only, the greater bulk of a generation issuing from the trees at the same time, and very often at night. This is one reason why these insects are so rarely met with in the forest in the daytime, and consequently why they have been so sparingly caught by collectors, and have not found their way into collections. And yet, as will be shown, if a forest officer or collector knows where to look for the insects, he will find them in numbers should the search be instituted at one of the periods during the year at which the insects appear on the wing. It is a common rule for these insects to pass through more than one generation or life cycle in the year, even in temperate climates. In India most of the species known pass through at least two generations in the year, and the number may be four, or even five in favourable seasons. Now, although the bulk of the individuals of any one generation issue at the same time, there are always some backward members of any one brood. These may have been kept back by a cold snap in a depression in which a few trees may be situated, or something may have caused an interruption during the egg-laying by the parent beetle. Oviposition in most cases would seem to be finished in a period of a week, and consequently, under ordinary circumstances, the last-laid eggs appear to mature into beetles almost as soon as those first laid, the difference being probably not more than forty-eight hours. Should, however, anything have occurred to interrupt the beetles whilst ovipositing, such as an outflow of resin by the tree, the last-laid eggs will mature at a considerably later

period than those laid at first. This results in a certain overlapping of the generations, and this overlapping always occurs in practice. In damp, cold seasons the overlapping is apparently greater than in dry ones, which are much more favourable to the insects.

In the majority of instances the beetles do not appear to feed to any appreciable extent after issuing from the tree. They possess to a remarkable degree that instinct which has already been described in the case of the Cerambycidae, which enables them unerringly to detect newly felled or standing sickly trees, and as soon as they issue from the tree in which they have developed they fly direct to a tree in the condition suitable for egg-laying. In some instances pairing takes place in crevices on the outer bark, at others in a pairing-chamber prepared by the male beetle inside the tree. The eggs, however, are rarely (in no instance in the case of the Indian species known) laid on the outer bark of the tree, or even in crevices in the bark, as is the case in the Buprestidae and Cerambycidae. The beetles always tunnel down into the tree to oviposit. The depth to which the beetle goes varies with different genera and species. Pairing may take place outside the tree, the female subsequently boring in to oviposit, or in other cases the male may eat out a pairing-chamber in the outer thick bark, or down in the inner bast, or in the outer sapwood. The female then either enters the tree by enlarging the male entrance-hole, or tunnels a fresh one of her own which hits off the pairing-chamber of the male. After fertilization here she carries a tunnel down to the bast, and then bores away from the pairing-chamber, grooving the bast or the bast and sapwood. Some bark beetles are polygamous, and two, three, or more females may enter the pairing-chamber of the male in this way, and, after fertilization, each carries her own egg-gallery separately away from the pairing-chamber. In the case of the wood-boring Scolytidae, i.e. those which oviposit in the sap- or heart-wood, the tunnel into the sapwood is often eaten out by both male and female, or commenced by the male and the female then enters it, is fertilized, and continues the tunnel down farther into the wood. In this latter work she may be aided by the male.

It has been said that the beetles usually issue at night from the trees in which they have been reared. Although this is often the rule, in the case of several of the Indian species, *Sphaerotrypes* of the sál and *Polygraphus* and *Tomicus* of the blue pine and spruce, for instance, I have found the beetles crawling about the bark of newly felled trees and tunnelling into them in the daytime. This has generally been the case, however, in areas where the beetles have been unusually numerous. It is at such times that the latter are preyed upon and consumed in large numbers by the predaceous clerid beetle *Thanasimus* (p. 508). Some species, *Polygraphus* and *Tomicus*, especially the former, crawl with ease over the bark, whilst others walk but feebly, and only appear really at home when in their tunnels.

Many species of bark beetles, or in some cases genera only, can be readily recognized by the plans of the galleries made by the mother beetle and her offspring, the larvae, in the bast and sapwood of the tree, or down in the interior of the wood. The female beetle, for instance, after pairing with the male in the pairing-chamber in the bast, grooves out a gallery, called the mother- or egg-gallery, which may be straight or may be serpentine, in the bast and sapwood in a direction parallel to the long axis of the tree. On each side of this gallery the beetle eats out little notches, depositing an egg in each as she goes along. When she has laid all her eggs the gallery ceases, or at most may be continued for a short distance, in which portion she herself dies. On hatching the larvae eat out each a gallery called the larval gallery, which is either more or less at right angles to the mother-gallery, or inclines downwards in the case of the first-laid eggs and upwards in the case of the last-laid,



I. II.

FIG. 306.—Plans of galleries of Scolytid beetles in bast. I, Monogamous ; II, Polygamous. *a*, egg-gallery ; *b*, larval gallery ; *c*, pupating-chamber ; *d*, aeration hole ; *e*, pairing-chamber.

being more or less at right angles from those eggs laid about the centre of the mother gallery. The larvae continue eating out their galleries, which usually serpentine to some extent, till they have reached full development in size. They then enlarge the end of the gallery either in the bast and sapwood or entirely in one or the other, and pupate in this chamber. On maturing, the beetle bores straight out through the layer of bark over it, taking the

Pairing-chambers, egg-galleries, and larval galleries of *Tomicus ribbentropi*, Steb., on
ner surface of living spruce bark. This shows the manner in which the female beetles tunnel
it their egg-galleries, and the method of feeding of the grubs which hatch from the eggs laid
the sides of the egg-gallery. North-West Himalaya.

most direct route to the outside. There is thus left indelibly imprinted in the bast and sapwood, or in the sapwood, or partly in one and partly in the other (the female gallery often grooving both bast and sapwood, whilst the larval galleries are entirely in the bast, as in the case of the *Tomicus* of spruce and blue pine), a "plan" consisting of the mother and larval galleries of the species. For any one species this plan is always the same, and an examination of these old plans thus left imprinted in the trees will always enable the former presence in the forest of this particular beetle to be definitely ascertained long after the insects themselves have left the trees. This is a point of the very greatest importance to the forester. The shot-holes on the outer bark of the tree, made by the beetles entering the tree and by their offspring tunnelling out of the tree on maturing, will tell the forester that bark beetles are present in the forest, but they will not enable him to decide the species present. By stripping off the bark he will be able to determine by the "plans" left in the bast and sapwood the actual species which performed the damage, should it be a bast beetle.

These plans made by Scolytidae in their operations in the tree group themselves into four distinct series of figures, according to the method of oviposition by the parent beetle and the mode of feeding of the grubs. The bark forms—i.e. those members of the family which lay their eggs in the bast layer of the tree as distinguished from the true wood-borers—will be first considered.

The true bark-borers include both monogamous and polygamous forms, and the plans of the galleries made by each are very different in appearance and easily recognizable.

The Indian monogamous forms are typically represented by the deodar *Scolytus* (p. 568), and the sál *Sphaerotrypes* (p. 476). The female beetle pairs with the male either outside or in the bark of the tree. In the first case the tunnel down through the bark may be commenced by the female, who then attracts the male near the entrance-hole, is fertilized by him, and then continues her tunnel down to the bast. This is the usual habit of the deodar *Scolytus*. In the second case the male bores a short way down through the thick bark of the tree and eats out here to one side a small pairing-chamber. The female crawls down this short entrance-tunnel or makes a short tunnel of her own which exactly hits off the pairing-chamber (cf. fig. 318, *c*, *e*, *f* on p. 482), pairs with the male in the pairing-chamber, and then continues the tunnel straight down to the bast layer. In each case, on reaching the bast the female proceeds to eat out a gallery in the bast which may be straight or may incline first to one side and then to the other (cf. *Scolytus major*, fig. 307). The gallery is usually carried up the tree parallel to its long axis, and may groove both bast and sapwood. As this gallery is eaten out the female gnaws little notches in it on each side at close and more or less regular distances apart, depositing in each an egg, surrounded by a little mass of fresh, soft wood-dust, which is placed in position with the hind feet. The beetle takes several days, up to a week

on occasions, to prepare the whole of the egg-gallery and lay all her eggs. The eggs hatch out within twenty-four to forty-eight hours, and the larvae of the first-laid eggs have already commenced to eat out the larval galleries before the mother has finished laying the eggs at the top of the galleries. In the case of most of the Indian monogamous bark beetles known, the mother beetle remains alive during most of the period the grubs are reaching full growth, moving up and down her egg-gallery, which is kept quite free of wood-dust, or remaining in the entrance-tunnel in the bark, which she thus effectually blocks up as with a plug, preventing predaceous insect foes from entering it to get at and devour the larvae, or to deposit their eggs in the egg-gallery from which hatch out predaceous grubs. The whole of the

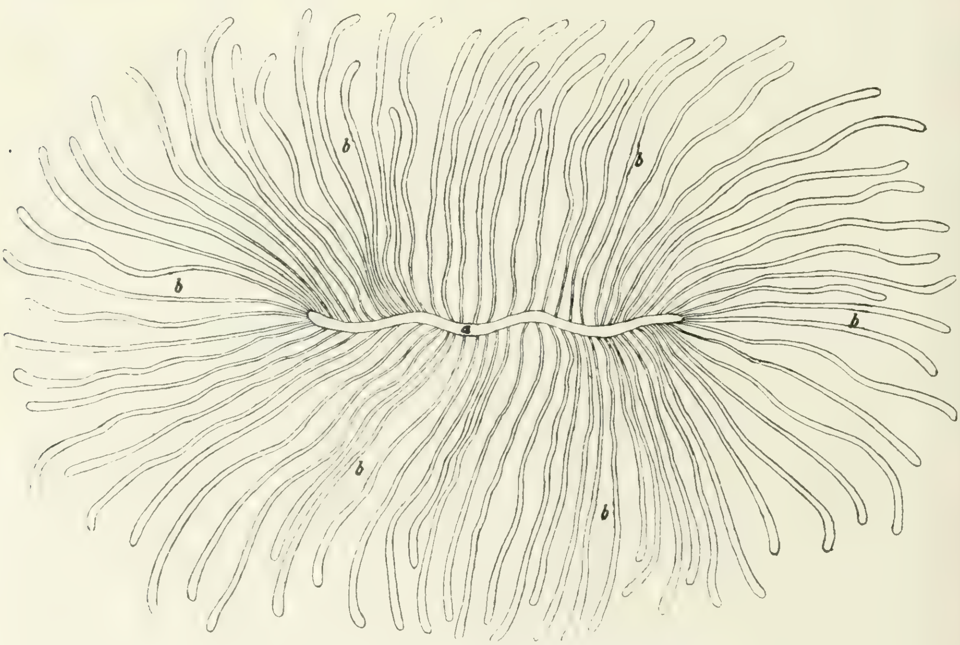


FIG. 307.—Egg and larval galleries of *Scolytus major*, Steb., in deodar.

bark and wood-dust eaten out in making the entrance-tunnel and egg-gallery are ejected through the orifice in the bark, and may often be found in small patches on the outer bark beneath the entrance-hole.

Coming now to the larvae. As soon as they hatch out from the eggs they devour the small mass of soft wood-powder with which the mother surrounded the egg, and then commence tunnelling more or less directly away from the egg-gallery. These galleries eaten out by the larvae groove the bast or both bast and sapwood, and increase in size with the growth of the grubs. They keep their main direction, but serpentine about to some extent. Those taking off from the centre of the egg-gallery are more or less

at right angles to it; those in the lower part of the gallery—i.e. that portion first made by the mother beetle—have a downward direction, whilst those in the upper part trend in an upward direction. The larval galleries are approximately equal in length to one another, and when completed the plan made by the mother and larval galleries has the shape of an elongate or blunt ellipse, the long diameter being formed by the egg-gallery. When full-fed the grubs either pupate in the enlarged end of their gallery or may hollow out a shallow chamber in the sapwood or bark and pupate in this. In both cases the beetles on maturing bore straight through the bark above them and leave the tree. In any event, the "plan" left by the operations of the mother beetle and larvae is always constant for that species, and enables its former presence to be easily recognized. A comparison of the plans of the galleries of *Scolytus major* (frontispiece) and *Sphaerotrypes siwalikensis* (fig. 19 on p. 33) will render this evident.

In the polygamous forms (which are typically represented by the Indian *Polygraphus*, *Tomicus*, and *Pityogenes*) the male beetle tunnels through the bark till it reaches the bast or outer sapwood, and eats out in either or both a small irregular-shaped depression, which forms the pairing-chamber, and remains in this. A female enters the pairing-chamber either by enlarging the entrance-tunnel of the male if she is of larger size than the male (which is often the case), or by boring an entrance-tunnel of her own which accurately hits off the pairing-chamber. On joining the male she is fertilized, and then at once commences eating out an egg-gallery which takes off from the pairing-chamber in an upward direction, but runs more or less parallel to the long axis of the tree. A second female now enters the tree by the entrance-tunnel of the male or that of the first female, and on reaching the pairing-chamber pairs in her turn with the male and then eats out her egg-gallery, which she carries in a direction opposite to that of the first female. If a third female enters, her gallery is taken up the tree, whilst that of a fourth will proceed downwards. In either event the galleries of the second and fourth females will diverge outwards from those of the first and second females, and will never cut into the latter. Each female as she eats out her gallery bites small notches in the sides and lays an egg in each. These notches are not, however, eaten out in the same regular manner as is the case with the monogamous bark-borers, nor in some cases are the eggs placed so close to one another. Also the major portion of the eggs are laid on that side of the gallery which is farthest from that of the neighbouring female egg-gallery (cf. fig. 328). In some cases, as e.g. *Tomicus ribbentropi*, the egg-galleries, with the notches in which the eggs are deposited, groove the sapwood deeply, whilst the larval galleries are eaten out in the bast only, and so are not visible on the sapwood (cf. pl. xl).

The larval galleries, which are eaten out by the grubs on hatching in a manner similar to that above described, are not so uniformly regular, and may wind about more. They are, however, always taken in a direction away from the egg-gallery, instinct appearing to teach the grub that no

sustenance will be obtained if it attempts to tunnel in the direction of the mother gallery.

The larval galleries are always—and this is also the case with the monogamous larvae—blocked with excreta and triturated wood particles which have passed through the larval body. When full-fed the grubs pupate either in the enlarged end of the larval gallery or very often in a chamber eaten out in the sapwood or in one eaten out in the bast or bark.

In the case of one Indian polygamous bark-borer (*Pityogenes*, p. 562) five or more females are fertilized by the one male beetle, and the five egg-galleries radiate in a stellate manner from the pairing-chamber, each gallery curving inwards, the eggs being laid on the outer side of the curve (cf. fig. 358).

In all these cases the plans of the egg and larval galleries are constant for the species, and are easily distinguished from each other, as will be seen by comparing the plans made by *Polygraphus* (fig. 333), *Tomicus* (pl. liii), and *Pityogenes* (fig. 358). In the polygamous forms the egg gallery may or may not be blocked with wood-dust and excreta by the female beetle. If it is, as in the case of *Tomicus*, where the gallery is also very long, the beetle eats out one or more aeration holes by boring a horizontal tunnel to the outer bark, leaving a thin lamella of bark on the outside intact. This tunnel serves to let air into the egg-gallery, whilst at the same time the thin lamella of bark covering it prevents predaceous foes from getting into the egg-gallery to devour the grubs. When the whole of the eggs are laid the female either dies in the tunnel just above the last-laid eggs, or continues the tunnel for a length of an eighth to a quarter of an inch and dies in this portion.

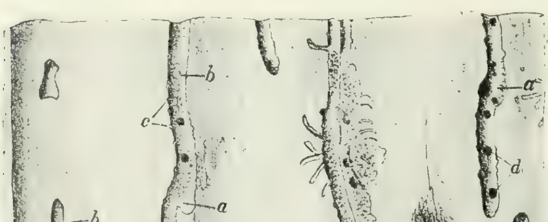


Fig. 308.—Piece of *Pinus Gerardiana* bark showing egg-galleries with egg-recesses made by *Polygraphus trenchi*, Steb. *a*, pairing-chamber; *b*, egg-galleries; *c*, egg-recesses; *d*, air-holes; *e*, larval galleries.

The wood-boring forms of the Scolytidae oviposit in the wood of the tree, and bore out tunnels which may go straight down into the wood or may enter the tree

PLATE XL.

Egg-galleries of *Tomicus ribbentropi*, Steb., in sapwood of spruce. The larval galleries are not present, as they groove the bast layer only. North-West Himalaya.

at an angle, subsequently turning and going straight down towards the heart of the tree. These forms differ in the way in which the tunnels are eaten out.

In the first case the female beetle bores down some distance into the sapwood, or the entrance-tunnel may be made by both male and female beetles. The female is then fertilized, and she continues her tunnel, eating out small offset tunnels in which one or more eggs are laid. The larvae on hatching out usually feed on fungus matter lining the walls of the tunnel and have therefore been called "ambrosia" feeders. The larvae when full-fed pupate in the offset tunnels, and the beetles when mature crawl into the main tunnel and up it to the outside of the tree. Both male and female beetles as soon as pairing and egg-laying are completed leave the tunnel. This latter, as is also the case with the offshoot tunnels, is completely free of all wood-dust and excreta (cf. fig. 385, *Scolytoplatypus*, p. 606).

In the second case the male and female carry the tunnel deep down into the wood, the tunnel going perhaps straight through the bark, taking a sharp

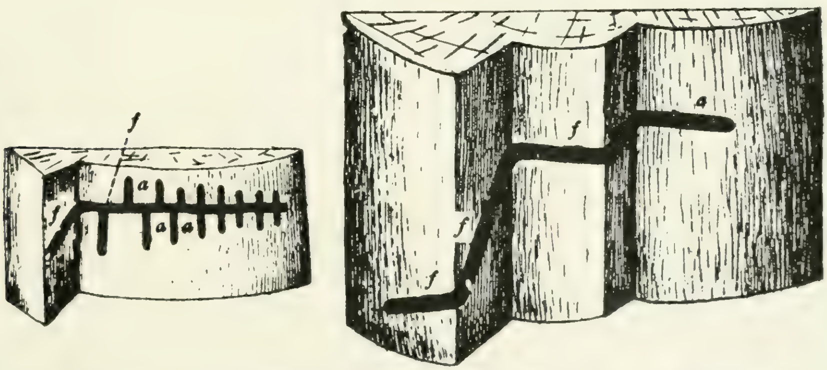


FIG. 309.—Plans of Egg Tunnels of the Scolytid Wood-borers. *f*, tunnel down into the sap- and heart-wood ; *a*, place where the eggs are laid.

bend in the outer sapwood, and then going down straight or on a curve or serpentine into the sapwood or into the heart-wood. The tunnel is uniform in width throughout, circular in shape, and has no offset tunnels to it. When deep enough in the wood the female lays her eggs at the bottom. The larvae on hatching out also feed on sap or fungus materials on the walls of the tunnel, and as they increase in size they lie naked in the tunnel one above the other and pupate in this position. When mature the beetles simply crawl up the tunnel and escape from the tree. This type of wood-borer is exemplified by the teak *Xyleborus* (fig. 381). Most of the known Platypodidae (figs. 389, 390) oviposit in this manner.

In the case of the main tunnel with the offsets it is possible to distinguish the beetle from the plan of the tunnels, but this is not the case with the simple tunnel without offshoots.

These wood-boring Scolytidae may be monogamous or polygamous, though in the majority of instances known the Indian species appear to be monogamous.

In many cases the winter is passed by Scolytidae either in the larval, pupal, or resting beetle stage, in the gallery or pupal chamber. If the grub has pupated and a severe cold winter is experienced, most of the pupae will probably be killed in the case of the bark-boring insects. If the beetle has matured and left the tree and a cold snap supervenes it bores a short way into the thick bark of old trees and hibernates here (cf. *Sphaerotrypes* in the sál, p. 477).

Damage done by the Family.

The family contains numerous species in India which are very destructive to trees, and research into the habits of the family is showing that the beetles, especially the bark-boring forms, play a very important part, and will play a still more important part in the future, in the economic life of the Indian forest.

The real danger to the tree occurs in the case of the groups which oviposit in the bast layer. Damage is done here by both beetle and larva, the former grooving out the egg-gallery whilst the latter eats out an offset gallery. A certain amount of the bast is thus removed by each. Consequently when a tree is attacked by a large number of beetles, thousands of egg-galleries may be eaten out in the bast. From each egg-gallery twenty to seventy or more larval galleries may take off, and may cover the whole of the main stem of the tree from base to the crown. In such cases the galleries when complete form an interlacing mass, practically the whole of the bast disappears, and the tree dies. This is a common feature of the attacks of the *Scolytus* in deodar, *Tomicus* and *Polygraphus* in blue pine, spruce, and long-leaved pine, and *Sphaerotrypes* in the sál. Under *Scolytus major* figures are given (p. 572) to show the large number of beetles which are reared in one tree under these conditions.

Bark beetles do not usually attack green trees unless driven to do so. For ovipositing purposes they seek out newly felled trees, windfalls, snow-broken trees, or standing sickly trees whose vitality has been reduced from one cause or another. In all cases the trees must possess absolutely fresh sappy bast, or the beetles will not oviposit in them. Felled trees or windfalls which have lain for a couple of months exposed to the rays of the hot Indian sun will not be attacked, and it would appear that the beetles will not oviposit in trees which have been felled or have fallen in thick shade. Should a supply of trees in the condition required by the beetles not be forthcoming on an area, the insects will attack green standing trees. The first series of beetles to infest the trees will in all probability be drowned in their partially constructed burrows by an outflow of sap or resin put forth by the tree. The tree responds with this outflow to each succeeding attack as long as its vitality enables it to do so. Should the number of beetles in the forest be excessive, succeeding attacks are successful and the tree is killed. Thus the

danger of green trees being attacked in the forest is entirely dependent on two factors:

(1) The presence in the forest of a sufficiency of felled trees, windfalls, and standing sickly trees.

(2) The abundance of the insects in the locality.

In the first case the presence of such trees leads to the increase of the beetles, since the conditions favour them. In the second case it should be possible to reduce to a minimum the danger of serious infestations of the insects by removing or barking at once all felled trees and windfalls, and removing all standing sickly trees, which, if left, serve as centres in which the insects raise a numerous progeny.

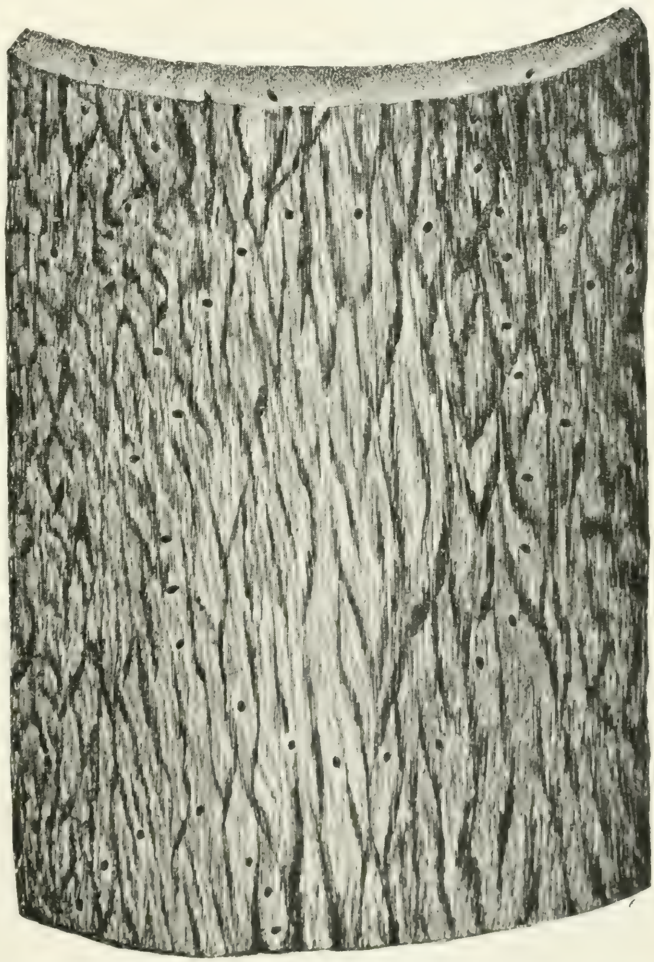


FIG. 310.—Exit-holes, or "shot-holes," of mature *Sphaerotrypes siwalikensis* beetles on outer surface of the bark of a sál-tree.

Coniferous trees infested by bark-boring Scolytidae are easily distinguishable when standing in the forest:

(1) The foliage turns yellow and the needles commence to drop off.

(2) The bark shows on the outside numerous pin or shot holes, made by the beetles entering the tree or issuing from it.

(3) The bark shows on the outside under the entrance-holes made by the beetles elongate pear-shaped drops or "tears" of resin. Trees so affected are said to "weep," and in the case of seriously infested trees the tears, often forming a drip down the bark for some distance, are very easily seen and are characteristic of the attack. Pl. xli shows the bark of

the *Pinus gerardiana*, infested by *Polygraphus trenchi*, covered with numerous tears of resin. In the case of the smaller branches the entrance-hole is usually marked with an elevated circular rim of white resin as shown in fig. 329. This is also the case with the thin-barked *Pinus gerardiana*.

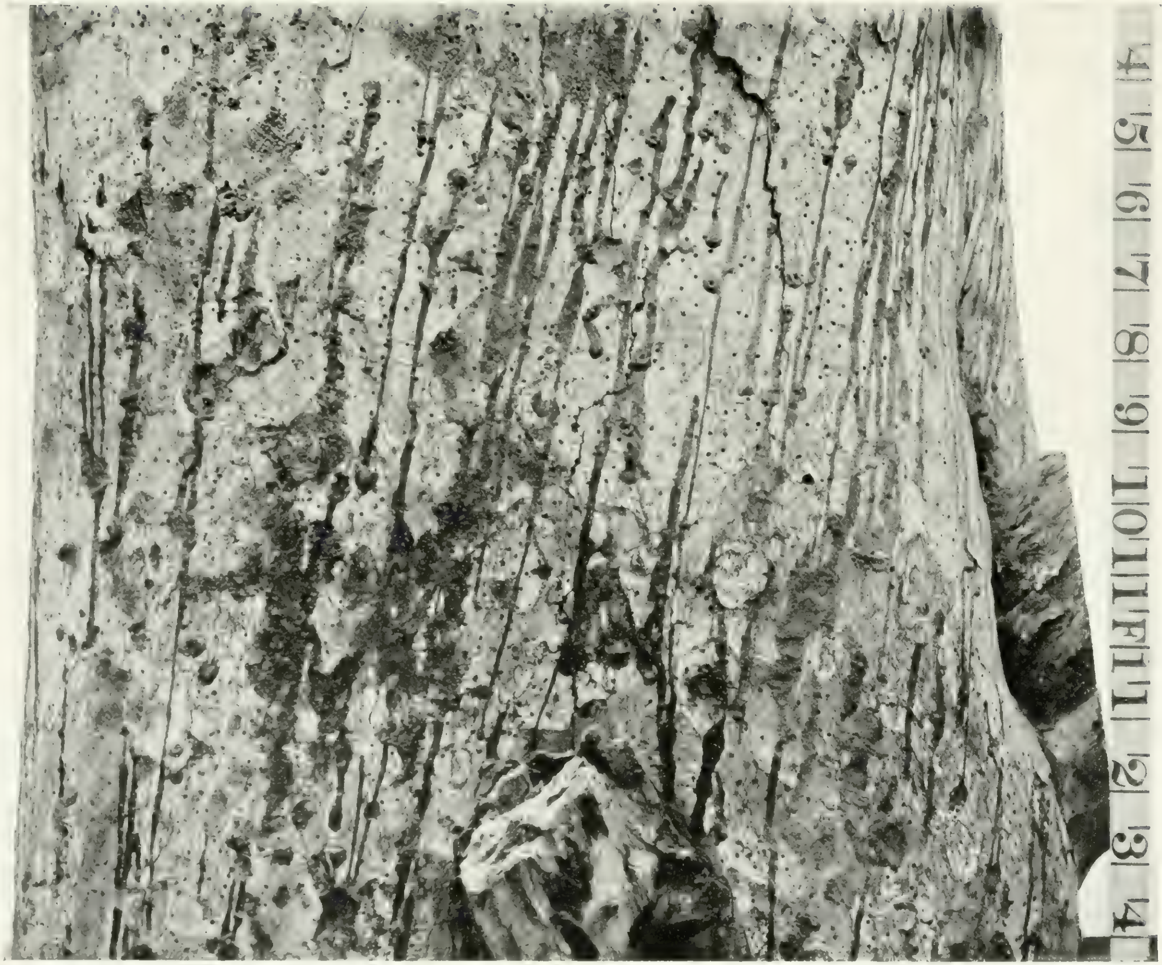
Another evidence of the attack which is common to both bark- and wood-boring Scolytidae is that masses of wood-dust may be found on the bark beneath the hole, ejected by the beetle from its gallery. This, with the entrance-hole in the bark, is very often the only evidence that trees have lost their vitality, and are therefore no longer capable of answering the attack by an outflow of resin until the later stage at which the needles begin to turn yellow.

Broad-leaved trees attacked by these bark-boring pests show no easily visible outward signs until the insects have obtained the upper hand and removed most of the bast layer. They then begin to flag, and the leaves turn yellow and drop off. Long before this, however, an inspection of the outer bark will show the numerous tell-tale pin-holes (fig. 310) and the ejected wood-dust particles, either protruding in little conical masses from the holes, or in dust beneath the latter.

The wood-boring forms of the family very rarely kill the tree, only perhaps when they are so numerous that the holes cover the bark from top to base. Their attacks are, however, serious when the insect is in large numbers, as the holes drilled into the timber entirely ruin its outward appearance for sale purposes, even if, as in many instances, the tunnels only penetrate for a few inches into the sapwood. These beetles attack the wood in various stages of dryness. Some will only infest newly felled, wind-thrown, or snow-broken trees, whilst others only tunnel into trees which have lost a certain amount of sap; finally, others will only oviposit in absolutely dry timber.

In 1899 the Government of India published a small work entitled *Injurious Insects of Indian Forests*, in which I had collected such information as was then procurable on the injurious insects of the Indian forests. The work was mainly compiled from *Indian Museum Notes*, with some few additions from observations made by myself. In this work the only Scolytidae included were a *Polygraphus* sp., since described as *Polygraphus major*, Steb.; *Pityogenes scitus*, Blandford; *Xyleborus perforans*, Wollaston; and undetermined species said to attack *Quercus incana*, sál, *Pinus longifolia*, and *Pinus gerardiana*.

Since that date a considerable amount of investigation work has been carried out regarding the relation of this family to the forests of the country by officers of the Department and others and by myself; many new species have been discovered, and valuable records on their economic importance have been compiled. This information is detailed in the following pages. Whilst some of it has been already published in my monographs and bulletins, much of it appears here for the first time.



Portion of trunk of *Pinus gerardiana* showing the "weeping" produced by the oozing of the resin from the entrance holes of *Polygraphus trenchi*, Steb. North Zhob, Baluchistan.

I would wish to record my deep obligation to my former instructor in Entomology at the R.I.E. College, Coopers Hill, Mr. F. W. Blandford, himself a well-known authority on the family; to Lieut.-Colonel F. Winn-Sampson, now engaged on work in this family and on the Platypodidae; and to that eminent authority, Dr. Max Hagedorn, for the great assistance so generously accorded me in this branch of my work.

Classification.

The Scolytidae have been recently subject to a complete revision* by that accomplished scientist Dr. Hagedorn, and unfortunately this revision has led to the disappearance of several well-established generic names, whilst the name of the family known to generations of foresters disappears. Dr. Hagedorn has but followed the commonly accepted dictum in scientific nomenclature that priority should be recognized in every case, but it is peculiarly unfortunate that the necessity should have arisen in such an important family economically to the forester as the Scolytidae, which he now calls Ipidae. The well-known genus *Tomicus* becomes *Ips*, whilst *Scolytus* is known as *Eccoptogaster*. It is inevitable that great confusion will arise owing to this revised nomenclature. I have deemed it therefore advisable to draw attention to the matter, in order that future students may make a first acquaintance with this revised synonomy as well as with the old one. In every case I have placed the revised generic name in brackets, but in order to avoid confusion in a work designed essentially for the use of the forester I have kept to the old and well-established nomenclature.

Dr. Hagedorn adopts the now generally accepted view, which I have held for some years, that the Platypodidae are a distinct family. He divides his family Ipidae (Scolytidae) into four sub-families, according to the presence of pubescence, spines, bristles, or pubescence and bristles on the edges of the middle jaw, to which he gives the names Pilidentatae, Spinidentatae, Saetidentatae, and Mixtodentatae. In the first sub-family he includes one tribe, in the second seven, in the third two, and in the fourth one. In all save the first sub-family Indian genera and species are well represented in the forests.

The following are the characters of the sub-families :—

i. *Pilidentatae.*—Edges of maxilla furnished with hairs.					
ii. *Spinidentatae.*—	,,	,,	,,	,,	spines.
iii. *Saetidentatae.*—	,,	,,	,,	,,	bristles.
iv. *Mixtodentatae.*—	,,	,,	,,	,,	hairs and bristles.

Sub-Family 1.—Pilidentatae.

This sub-family contains the tribe Phloeotrupinae, including the three genera *Dactylipalpus*, *Phloeoborus*, and *Phloeotrupes*. No Indian species of this sub-family are yet known to be injurious in the forests.

Sub-Family 2.—Spinidentatae.

Edges of the middle jaw fringed with spines. This sub-family contains the largest number of the at present known Indian genera, the whole of the injurious bark-boring and bast-feeding pests coming here. The sub-family is divided into seven tribes, the Diamerinae, Hylesininae, Crypturginae, Cryphalinae, Ipinae, Hylocurinae (no Indian species), and Eccoptogastrinae. These tribes include the important Indian genera *Diamerus*, *Hylastes*, *Hylesinus*, *Sphaerotrypes*, *Phloeosinus*, *Chramesus*, *Crypturgus*, *Polygraphus*, *Cryphalus*, *Coccotrypes*, *Dryocoetes*, *Pityophthorus*, *Tomicus* (*Ips*), *Pityogenes*, and *Scolytus* (*Eccoptogaster*).

* Wytsman, *Genera Insectorum : Coleoptera*, fam. *Ipidae*, von Max Hagedorn (1910).

Tribe DIAMERINAE.

Tibiae with outer edge smooth; front tibiae lengthened out into a one- or two-toothed hook. Abdomen horizontal.

DIAMERUS.

Only one species of the genus of forest importance is known.

Diamerus fici, Blandford.

REFERENCE.—Blandford, *Trans. Ent. Soc. Lond.* 426 (1898).

Habitat.—Tista Valley, Eastern Himalaya.

Tree Attacked.—India-rubber (*Ficus elastica*), Tista Valley.

Description.

Beetle.—Oblong, black, sub-opaque, the antennae and tarsi piceous brown. Head slightly shining, closely but not very strongly punctate, and furnished with very short, accumbent grey pubescence; front impressed between the antennal foveae, convex above, and with a slight median nodular elevation, somewhat more shining; eyes oblong-oval; antennal club flattened, obovate, somewhat blunt at apex, very closely pubescent, with a strongly angulate suture towards the base. Prothorax constricted anteriorly, the sides rounded, lateral margins distinct, dorsum convex, with very close but not coarse punctation, and a sub-carinate median line from the base to the middle. Elytra twice as long as the prothorax, separately and strongly rounded at the base with narrow, raised, crenate margins, carried back obliquely and sinuate at the sides; surface with moderately deep incised shining crenate striae, the interstices sub-convex, with close and rather fine punctures bearing very short and inconspicuous setae. Under-side strongly punctured and pubescent with short grey hairs. Legs robust, the anterior tibiae widened apically, the upper apical angle with a backwardly directed tooth; middle and posterior tibiae with the upper border rounded and crenate. Length, 5.5 mm.

Life History.

To my knowledge only one individual of this species has been as yet taken. It was from this insect that Mr. Blandford described the species.

The beetle appears on the wing apparently in the latter part of July. On the thirtieth of that month (in 1897) I found a beetle tunnelling into or ringing (I was not sure which) a young india-rubber cutting in a nursery situated in the Tista Valley (Tista Division). The cuttings had been in about a year, and had already thrown out several leaves, and the one being attacked was quite healthy.

Tribe HYLESININAE.

Tibiae never prolonged into a hook or process at outer angle. Head provided with a rostrum. Hind joint of tarsus broadest.

The tribe contains a peculiarly Indian genus, *Sphaerotrypes*, which includes species of great economic importance in the plains forests. The genera *Hylastes*, *Phloeosinus*, and *Chramesus* also contain Indian forest species.

Hylastes.

Two species, whose life histories are partly known, infest Coniferae in the Himalaya.

Hylastes himalayensis, Stebbing.

REFERENCES. Stebbing, *Ind. For. Mem.*, Zool. Ser. vol. i, pt. ii. p. 14 (1909); ibid. *Depart. Notes* (*Hylastes* sp.), i, 201.

Habitat.—North-West Himalaya.

Trees Attacked.—Spruce (*Picea morinda*); Blue Pine (*Pinus excelsa*). Jaunsar, Kumaun, Chamba, Simla, 3,500 ft. to 8,000 ft.

Description.

Beetle.—Elongate, shining, dark red-brown to black, punctate. The third tarsal joint wider than the preceding joints. Head smooth, shining, with scattered rather large punctures on vertex; a transverse median depression below vertex not reaching the sides; rostrum somewhat constricted, widest at base, not carinate; front roughly rugose-punctate, the punctures finer medianly and the rugosities more prominent on the rostrum. Prothorax constricted at apex, the sides angulate and sinuate; punctate, the punctures of two kinds; large squamulose and confluent on sides, finer and not confluent on disk and anterior median portion. Elytra wider than thorax and twice as long, widest at apex, sides very slightly rounded to basal fourth, and thence slightly sinuate to base; striate-punctate, the striae prominent and punctured, the interstices rugose with short fine hairs. Under-surface black, covered with scattered fine white hairs; middle coxae fairly wide apart. Legs dark reddish-black. Antennae yellow, tibiae red-brown. Length, 3 mm. to 3.5 mm.

The male beetle is of smaller size than the female.

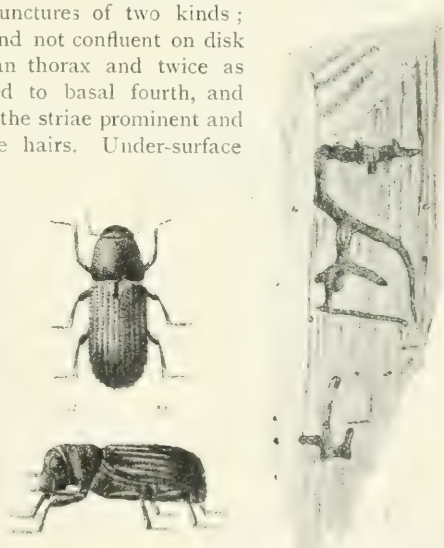


FIG. 311.—*Hylastes himalayensis*, Steb. *a*, beetle; *b*, egg-galleries in a piece of blue-pine wood.

Life History.

The beetle appears on the wing about the second week in May at the higher altitudes at which it lives, and is to be found in the trees at various elevations up to the middle of June. Another generation makes its appearance in September–October. The beetle, after tunnelling through the bark of the tree, eats its way down into the heart-wood. The entrance-tunnel may go horizontally through the bark into the sapwood (in a standing tree), or may be at an angle. In any event, on reaching the sapwood the angle is altered, and the long egg-gallery taken at an angle to the entrance one. Short offset galleries are eaten off on either side near the extremity, and eggs laid in them. I have not yet taken the grubs of the insect, although I have taken the beetle in considerable numbers during several years.

The male and female pair in the tunnel inside the tree, and the male appears to help the female in boring a portion at least of the long gallery

into the wood. It is not improbable that the first portion of the tunnel as far as the pairing spot inside the tree is the work of the male beetle, the female continuing the tunnel into the heart-wood after fertilization. In pairing the male mounts on to the back of the female.

An autumn generation appears in September–October.

Relations to the Forest.

The beetle is apparently a wood-borer only, and enters the tree when it is dying or nearly dead. So far as present observations go, it does not infest dead or dry trees, as it requires that there shall be a certain amount of sap in the wood for its grubs to feed on. I have taken the insect in considerable numbers in girdled and nearly dead blue-pine trees in Jaunsar. The beetle is very often found associated with *Rhyncholus himalayensis* of the blue pine and spruce. It tunnels deeper down into the tree than the latter insect.

Ichneumon sp.—This Ichneumon is parasitic on the *Hylastes*, and perhaps also on *Rhyncholus himalayensis*.

FIG. 312 - Ichneumon sp. (× 3), parasitic upon *Hylastes himalayensis*, Steb., and *Rhyncholus himalayensis*, Steb. North-West Himalaya.

Parasitic and Predaceous Insects.

Fly.—A black, shining, delicate fly, with a very long ovipositor, longer than the insect itself. Antennae of medium length ; wings longer than the body, with a stigma on outer edge of upper wing. Legs reddish. Length, 6 mm.; ovipositor, 9 mm. ; expanse of wings, 12.3 mm.

I cut out a specimen of the Ichneumon from the bottom of a long egg-tunnel of this *Hylastes* in a dead blue-pine in Jaunsar. The fly was mature, and was taken on 5 May 1902. The wood of the tree was riddled with the tunnels of this insect and with those of *Rhyncholus himalayensis*. The Ichneumon grub had evidently fed parasitically on one or more of the hylastid ones. This is the only occasion on which I have taken this parasite.

Platysoma rimae, Lewis (p. 105).—This histerid is predaceous upon the hylastid. The insect is described on p. 576.

Paromalus sp. nov.—This insect, already described as predaceous upon *Rhyncholus himalayensis* (p. 453), also attacks and is found commonly with this hylastid.

Hylastes longifolia, Stebbing.

REFERENCE.—Stebbing, *Ind. For. Mem.* Zool. Ser. i, pt. ii, 3.

Habitat.—N.W. Himalaya.

Tree Attacked.—Chir Pine (*Pinus longifolia*). Tons Valley, Jaunsar ; Kumaun ; Ravi Valley, Chamba.

Beetle.—Elongate cylindrical; black, shining, uniformly punctate. Smaller than *himalayensis.* Head with vertex smooth, with a few scattered fine punctures; the transverse depression below vertex more prominent than in *himalayensis;* rostrum wide, scarcely constricted, and not carinate; front uniformly pitted with small punctures more prominent than on vertex. Prothorax shaped as in *himalayensis;* the punctation is, however, quite different, the punctures being uniform in size and arranged in symmetrical, longitudinal, parallel, equidistant rows save near apex, where they are closer together; on anterior margin a smooth area finely punctate, broadest medianly, thinning out laterally on either side. Elytra with a slightly reddish tinge, a little wider than thorax and nearly three-fourths as long again, as wide at apex as at base, somewhat constricted in basal third, apex bluntly rounded. Striate-punctate, striae deep, punctures small and very uniform, interstices prominent, smooth, shining. Both upper and under surfaces are distinguished by an absence of hairs. Under-surface black, uniformly punctate; punctures large save on abdominal segments, which are finely pitted. Middle coxae closer together than in *himalayensis.* Length, 2.6 mm. to 3.05 mm.

Description.

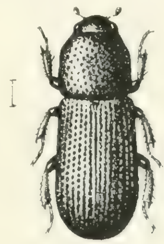


FIG. 313.
Hylastes longifolia, Steb. N.W. Himalaya.

Life History.

This beetle comes into the tree as the *Tomicus* and *Polygraphus* bark beetles of this pine, described later on, are leaving it, i.e. it does not require the bark and wood to be as fresh as is the case with the others. This I have noticed to be the rule with the *Hylastes* of the blue pine and spruce. The insect will not, however, attack dry wood.

The beetle bores through the bark down to the inner bark layer, and makes a central pairing-chamber from which radiate several (two or more) galleries (filled with white wood-powder) in a fan-shaped manner. These galleries, after zigzagging in the bark for some distance, are then carried down into the wood at an angle which may be very acute or otherwise. The zigzag gallery in the bark varies greatly in length; it may be very long or very short. This gallery grooves both bark and wood and is filled with white wood-dust, and so is easily seen in the dark-red inner bark. After entering the sapwood the beetle may turn and bore in it in a direction parallel to the circumference of the tree for a time, and then again turn and bore right down into the heart-wood of the tree. This procedure agrees with that of the *Hylastes* of the blue pine and spruce. The deep tunnel in the wood is to lay her eggs in. The probable procedure is that the male bores down to the inner bark, the females pair with him there and then eat out their zigzag galleries in the bark, subsequently going down into the wood.

A generation of this beetle was found tunnelling into trees to oviposit in late May and early June in Kumaun and in the middle of June in Chamba, whilst another generation was taken, occupied in a similar manner, towards the end of October in the Tons Valley, in Tehri Garhwal.

This beetle is a wood-borer, though by no means so dangerous a pest in this way as the *Platypus biformis* described on p. 619. On the other hand, when the insect is numerous it is capable of destroying a certain amount of the cambium layer of the tree, owing to the habit of the females of carrying their galleries at first in the cambium layer and sapwood.

Damage Committed in the Forest.

As regards protection, the method of treatment would be similar to that for the *Platypus* (p. 620).

This may be one of the insects alluded to by Mr. Norman Troup as infesting the wood of the *Pinus longifolia* in Kumaun.*

SPHAEROTRYPES.

A very important genus of globular bark beetles, which chiefly infest broad-leaved trees in the plains forest. It is interesting to note that the genus is widely spread, extending throughout India (including Baluchistan) and into Lower Burma.

Sphaerotrypes siwalikensis, Stebbing.

REFERENCES.—Stebbing, *Depart. Notes*, i, 389 (1906); id. *Ind. For. Mem.* Zool. Ser. i, pt. i, p. 3 (1908).

Habitat.—United Provinces.

Trees Attacked.—Sál (*Shorea robusta*); *Anogeissus latifolia*; *Terminalia tomentosa*. Siwaliks, United Provinces Terai, Oudh.

FIG. 314.
Sphaerotrypes siwalikensis, Steb. × 6.
Siwaliks, Northern India.

Beetle.—Elongate, globular, very convex above. Black, with often a reddish tinge on the thorax and basal portion of elytra. Head black, punctate; antennae yellow; prothorax with anterior margin half the width of the posterior, the margin produced forward into a lobe in the middle, with a transverse depression below it; sides rounded, posterior margin produced backward medianly into a sharp point, a fine raised longitudinal black line down centre, the rest of surface being covered with slightly raised irregular elevations. Elytra longitudinally striate with the intervals consisting of rows of prominent rounded serrate elevations, like blunt teeth; the elytra taper slightly towards apex, the basal margin being angularly convex and serrate; the basal fifth is often red in colour and much less deeply striate, and the elevations are less prominent than on the rest of surface. Under-surface black, the abdominal segments thickly clothed with longish yellow hair. Legs brown, tibiae serrate on edge, tarsi lighter-coloured. Length, $\frac{1}{7}$ in. to $\frac{1}{9}$ in. The black elevate line down prothorax, and the remarkably deeply striate and corrugate elytra, serve to distinguish this insect.

Description.

FIG. 315.
Larva of *Sphaerotrypes siwalikensis*, Steb. × 6.

Larva.—White, curved, legless, thick, robust, and much corrugated, with a small brownish-yellow head; very convex dorsally, flat ventrally, and elliptical in section.

Pupa.—Almost spherical in shape, white, has the appearance of beetle, but is soft, and legs and antennae and wings are compressed against the sides and breast.

* *Journ. Bom. Nat. Hist. Soc.* vol. xviii, p. 19 (1907).

Life History.

This *Sphaerotrypes* is the bark-beetle pest *par excellence* of the sál forests of the United Provinces, and probably extends into the sál areas in Nepal to the east. The beetle primarily infests the sál-tree, but is also to be found attacking *Anogeissus latifolia* and *Terminalia tomentosa*. The insect is often found infesting the sál in company with the longicorn *Æolesthes holosericea* (p. 301).

The beetle hibernates in the outer layers of the thick dead bark of the larger sál-trees in the forest, tunnelling into the bark about half an inch. The bark of large trees may often be found to be pitted with small holes in the winter months, and if these are cut into, either this beetle will be found or the predaceous histerid *Niponius*, which feeds upon it. The bark-borer makes its first appearance in the year about the middle of March in dry warm years, the beginning of April in cold wet ones. The insect is gregarious, issuing from the trees in swarms and flying together to attack fresh ones. The female usually pairs with the male in the outer bark of the tree, the beetles boring in at separate points, the tunnels meeting in the outer bark. After fertilization the female beetle continues her tunnel down to the bast, and then eats out a gallery in this latter parallel to the long axis of the tree, and grooving both bast and sapwood. In this gallery she lays her eggs, thirty-five to forty in number, in little indentations made on each side all the way up. It is possible that she pairs with the male more than once, crawling back to the pairing-chamber at intervals during the construction of the egg-gallery. The length of the egg-gallery is $\frac{7}{8}$ in. to $1\frac{1}{8}$ in. The larvae on hatching out bore galleries away from the egg-gallery at angles which deviate more and more from the right angle the nearer they approach to the extremities of the female gallery (fig. 19, p. 33). The length of the larval gallery is $1\frac{3}{4}$ in. or a little more.

On becoming full-fed the larva, whose gallery grooves both bast and sapwood, enlarges the end of its tunnel into a small chamber, and changes into a pupa in this. The beetles on maturing leave the pupal chamber by boring out horizontal tunnels straight through the bark to the outside (fig. 310).

Fig. 19 shows the plan of the galleries made in the bast and sapwood by the female beetle and the larvae. This plan is always constant for this beetle and never varies. As each larva bores out the pupating-chamber of the future beetle at the end of its larval tunnel, and as the tunnels are all more or less of the same length, if the outer bark of the tree is examined after the new brood of beetles has left it a roughly-shaped ellipse of exit holes will be seen upon it, as shown in fig. 310.

Owing to the pattern thus left in the outer bark by the exit-holes of the new generation of the beetles, an examination of the bark of infested trees will show whether the beetles being raised in the tree have left or not.

The mother beetle, as is the case with the *Scolytus* of the deodar, remains alive for a considerable time after finishing ovipositing, the entrance-tunnel in the bark and the egg-gallery being kept free of all wood particles and dust: the larval galleries are, however, closely packed with these materials and larval excreta. The female finally dies in the entrance-tunnel, and thus blocks it. The predaceous histerid beetle *Niponius andrewesi* appears to be aware of this habit of the *Sphaerotrypes*, and usually crawls down the entrance-tunnel, thus reaching the lower part of the egg-gallery, where she oviposits whilst the bark beetle is still engaged in eating out the upper portion of her gallery and completing her egg-laying operations.

The eggs laid by the March beetles are those of the first generation of the year. The larvae hatch out within three to four days of the eggs being laid, perhaps in even a shorter period, and become full-fed at about the end of April. The pupal stage lasts from ten days to a fortnight, and the first generation of beetles issues some time in May. The May beetles lay eggs which give rise to the second generation of beetles about the end of June to the middle of July; these lay eggs which produce a third generation of beetles at the beginning of September; a fourth generation of beetles, from eggs laid about the first week in September, emerges in the first week in October; the eggs from these give rise to the beetles which are found in the bark of standing trees in the winter season; they issue about the middle of November. It is probable that the whole of this, the last generation of the year, rarely matures before the first cold of the winter sets in. The immature pupae and full-grown larvae have then to hibernate in this condition in the larval galleries. To do this the larva spins around itself a fine silken cocoon, and thus usually manages to pass safely through the winter. Most of the pupae are probably killed off by the cold.

In May 1902 I discovered the beetle tunnelling into a small green shoot of a living sál-sapling in the Dehra Dun forests. The beetle was alive and only the extremity was visible, the rest of the insect being buried in the green shoot. In subsequent years I was able to corroborate this observation and to ascertain definitely that the beetle tunnels into and feeds in young green sál-twigs.

During the cold season of 1908, Mr. Reich, a third-year student at the Imperial Forest College, Dehra Dun, discovered a dying *Anogeissus latifolia* tree in the Garhwal Division showing the characteristic galleries of this insect. Unfortunately no beetles were procurable. The writer had previously taken the insects tunnelling into newly felled *Anogeissus latifolia* posts in April 1905, at Horai, in the Kumaun Division, United Provinces.

In September of 1908 and of 1909 I had some green sál and *Terminalia tomentosa* trees felled at Lachiwala, in the Dun, and investigation showed that the *Sphaerotrypes* also infests the *Terminalia* in a manner similar to that of *S. globulus* (cf. pl. xlii), although not apparently so readily as the sál when the two trees are present together in the locality.

Egg and larval galleries of *Sphaerotrypes globulus*, Blandford, on the outer sapwood of *Terminalia tomentosa*. Mandla, Central Provinces.

Damage Committed in the Forest.

This beetle is essentially a bast tunneller, i.e. the female requires the fresh cambium layer of the tree to oviposit in, and the grubs require the same to feed in. Thus the insect will only attack either standing sickly trees in the forest or newly felled ones. If, however, there are none of these in the forest and the insect is in great abundance, it will attack healthy green trees. It infests trees from the young pole stage onwards. Serious attacks of the insect will be found to commence at a centre and spread concentrically outwards. This and the fact that the pest is capable of increasing very rapidly in numbers when conditions are favourable to it constitute the danger of this beetle in the forest. It must be remembered also that its habit, as a mature beetle, of tunnelling into young green twigs and leading shoots of saplings to feed may prove very harmful to young growth in plantations and coppice areas.

The fact that the beetle also infests the *Anogeissus* and *Terminalia* is of considerable importance. These trees are often felled and used for building houses and bridges in the forests, and for sale, or felled and left *in situ* in cleaning operations. It must be remembered, therefore, that all green parts of these trees left in the forest are liable to be infested by this beetle, and consequently aid in its increase in the locality.

Protection and Remedies.

All trees felled should be at once barked, or if they are left as trap trees with the bark on they should be barked as soon as they are full of larvae, and before these have pupated and begun to issue as beetles. In leases given for the felling of sál-trees in coupes, a clause should be inserted enforcing the barking of the trees as soon as felled.

In the Siwalik sál areas there is a considerable sale of sál-posts (termed locally "tors"). These are cut during the cold-weather months, and should be all removed from the forest by the end of March. Provided this is strictly adhered to, there will be little chance of these posts assisting in the multiplication of the beetle. The tors will not be attacked if stacked in the sun two or three miles, or even less, from the forest, as the beetle will not lay in rapidly drying bark, which would not provide sustenance for the larvae when they had hatched out from the eggs.

There can be little doubt that this beetle may prove a source of serious danger to coppice coupes, if it once becomes numerous in adjacent areas of high forest undergoing improvement by the removal of all stag-headed, deformed, and sickly trees. As the older areas became cleaner the issuing swarms of bark-borers would be forced to attack the green trees. It is more than probable that coppice areas would be chosen. The attack would be certain to begin in patches, the insect working outwards from a centre. If patches of trees in coppice or pole forest appear to be dying, the bark should be carefully examined. If covered with small shot-holes on the

outside, especially beneath the projecting edges of flakes and in crevices, portions should be stripped off and examined on the inside. If, as will be the case when the beetle is numerous, the inner bark and sapwood are found to be riddled with galleries containing larvae, pupae, or beetles, the whole patch affected should be cut out, and the trees either barked at once and the bark burnt, or if the barking is not possible the whole of the cut-out material should be stacked and burnt. Trap trees should be left and watched.

After the great frosts of February 1905, careful examinations of areas affected, both in the Siwaliks and adjacent sál areas in the Terai and in the Pilibhit forests, showed that the *Sphaerotrypes* beetle was steadily increasing in numbers in the partially killed and moribund trees. The numbers of these trees were so great that it is likely that it will be some years before the beetles begin to find a scarcity of trees to oviposit in. When that date arrives, however, there will be a danger of a severe attack of this pest in the forests unless its predaceous and parasitic foes are able to keep it in check.

Parasitic and Predaceous Insects.

Two insects are known to prey upon this *Sphaerotrypes*, a histerid beetle and an ichneumon. I think there is a third, a clerid beetle allied to *Tilliœra assamensis* (p. 486), but I have never taken it feeding on the bark-borer. The histerid beetle *Niponius* has a wide range in India.

Bracon sp.—This is a small fly, blackish in colour, with two pairs of membranous wings; antennae and legs are long and slender. The fly probably lays its eggs in the entrance-tunnels of the bark beetles; on hatching out, the young grubs crawl down the tunnel to the newly hatched bark-borer grubs and parasitize these, either living inside them or on the outside. The bark-borer finally dies of exhaustion, and the braconid grub then pupates, the fly on maturing crawling out of the tree through one of the exit-holes of the beetle.

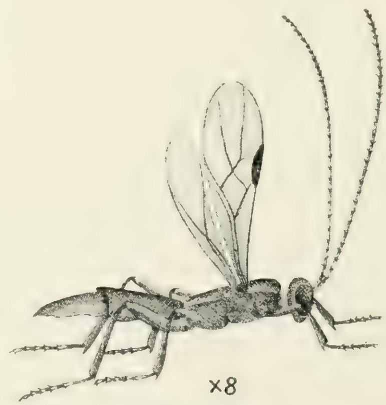


FIG. 316.

Bracon sp., parasitic upon *Sphaerotrypes siwalikensis*, Steb. Siwaliks.

Niponius andrewesi, Lewis (p. 102).

Grub.—Pink in colour, with a yellow head. Elongate and narrow, with twelve body-segments. Length, ½ in. to ¾ in. It is to be commonly found in the larval galleries of the sál bark-borer; it feeds upon the grubs of the bark-borer.

Beetle.—Elongate, narrow, shining black in colour; the wing-cases are short, leaving exposed the last two segments of the body, which are orange-red in colour. Head deeply cleft medianly. Elytra striate-punctate; pygidium punctate.

Life History.—The grubs of this beetle feed upon those of the sál bark-borer. The clerid has the same diameter as that of the bark-borer beetle, and can thus enter after the latter into its tunnels and oviposit there.

It is obvious that since this beetle is an enemy of the bark-borer it should never be killed. The beetles or their grubs are always to be found in company with the sál bark-borers, and probably pass through the same number of generations in the year as their hosts. The *Niponius* hibernates in the beetle stage in thick sál-bark in a manner similar to that of the bark-borer. (*Vide* additional note on p. 490).

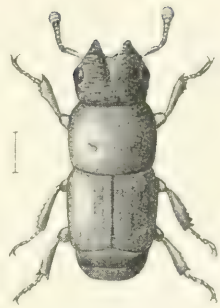


FIG. 317. *Niponius andrewesi*, Lewis. Upper and Lower India, Assam.

Sphaerotrypes assamensis, Stebbing.

REFERENCES.—Stebbing, Some Undescr. Scolyt. from Ind. Regions, *Ind. For. Mem.* Zool. Ser. vol. i, pt. i, p. 4 (1908); id. Some Assam Sál Insect Pests, *Ind. For. Bull.* no. 11, p. 23 (1907).

Habitat.—Assam and Bengal Duars Sál Forests.

Tree Attacked.—Sál (*Shorea robusta*). Goalpara, Bengal Duars.

Description.

Beetle.—Small, globular, very convex above. Black, slightly shining. Prothorax uniformly punctate, with a slight longitudinal median line. Elytra with deep longitudinal striae, the interstices being filled with rows of elevated prominent black scales. There is a row of stiff short hairs on the anterior margin of prothorax. Easily distinguished from *siwalikensis* by the deeper striae on the elytra, which become more pronounced as they approach the apex, instead of becoming obsolete; by the black colour of the elytra and by the more open and definite punctation of the elytra; also by the more strongly raised line on the prothorax. Distinguishable from *coimbatorensis* (as is *siwalikensis*) by the much more obtuse angle formed by the junction of the bases of the elytra, the angle being sharply V-shaped in *coimbatorensis*; the larger size also distinguishes it from this latter. Under-surface black, finely punctate; antennae yellow; tarsi piceous brown; tibiae set with a fringe of white hairs. Length, 2.8 mm. to 3.6 mm. Fig. 318, *a*, *b*.

Larva.—White, short, squarish in outline, dorsal surface slightly convex. Head small, yellow. Resembles a large white tick in appearance.

Life History.

The beetle makes its first appearance some time early in March and lays its eggs in the bast and sapwood of newly felled trees or in standing sickly ones. The upper part of the trunk and the crown of a large green tree felled in February were found to have been badly attacked soon after felling; the generation of beetles raised in them issued at the end of April, and in the middle of May had already oviposited in neighbouring trees. None of these beetles or others of the same generation had oviposited in the bark of this tree since it had become too dry. They require absolutely green cambium. The male beetle bores down about a quarter of an inch into the bark of

the main stem or thicker branches at an angle, and hollows out to one side of the tunnel a small chamber, large enough to afford space for two beetles (fig. *c*). This is the pairing-chamber. The female usually enters the pairing-chamber by boring a separate tunnel through the bark, which hits off the chamber. She is fertilized by the male, and then continues the entrance-tunnel down to the bast. On reaching this she eats out a gallery in the longitudinal axis of the tree approximately at right angles to the entrance-tunnel. This is the egg-gallery, and is about an inch in length. The eggs are laid in this, and the larvae hatch out and mature in a manner similar to that already described for *S. siwalikensis* (p. 477). The larval tunnels are winding; they increase in size with the growth of the grub, and

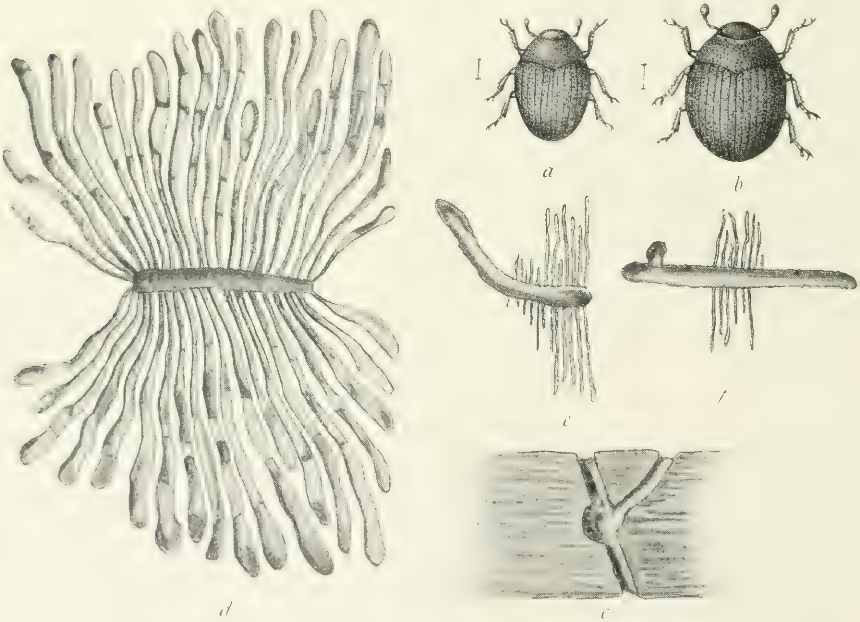


FIG. 318.—*Sphaerotrypes assamensis*, Steb., in the sál-tree in Assam. *a*, male; *b*, female beetle; *c*, entrance-galleries of male and female beetles and pairing-chamber in the bark; *d*, egg and larval galleries; *e*, *f*, uncompleted egg and larval galleries in green trees full of sap. Assam and Bengal Duars.

are tightly packed with the wood excreta. The plan of egg and larval galleries is very constant and uniform, forming a bluntly rounded ellipse (fig. *d*). When numerous the beetle will lay its eggs in small branches. On these the bark is necessarily too thin for the beetle to hollow out its pairing-chamber in it, and instead this latter is made in the sapwood and bast. The egg-gallery is commenced to one side of the pairing-chamber, the latter being usually situated about an eighth of an inch up the former and to one side (fig. *f*). The egg-gallery is not invariably straight. It may be curved or

even bent sharply to one side, but this latter is not usual. It was especially visible in the case where the insects were egg-laying in very green trees (fig. *e*). The number of eggs laid is thirty-five to forty on each side of the gallery, or seventy to eighty in all per beetle, and the larval galleries are two inches in length. The male beetle remains alive whilst the female is eating out the egg-gallery and ovipositing, and is usually to be found blocking the entrance-tunnel near the pupating-chamber. Since the beetle is preyed upon by *Niponius andrewesi* (p. 480), which enters the tunnels of the bark-borer, the continued presence of the male would seem to be for the purpose of protecting the female; or it may be, as already mentioned under *siwalikensis*, that the female pairs with the male several times during the process of constructing her gallery.

At the end of April the insect is to be found in the full-grown larval, pupal, and immature and mature beetle stages in the trees, this being evidently the first generation of the year. A proportion of the beetles will have already issued and will be found egg-laying in other trees. A comparison will thus show that this insect in Assam is nearly a generation ahead of its confrère *S. siwalikensis* of the Northern India sál areas. The fact that a generation of beetles has left the tree can easily be ascertained, as, owing to the ends of the larval galleries, i.e. the pupal chambers, being all situated on the circumference of a rough ellipse, and to the fact that the mature beetles bore straight out of the bark from the pupal chamber in the bast layer and sapwood, a regular series of exit-holes forming an ellipse is to be seen on the outer bark. When they have matured the beetles leave the trees in swarms together at night, and search for suitable trees in which to oviposit. By the middle of May the beetles of the first generation of the year were busily egg-laying in the Kachugaon forests, and some larvae had already hatched out and commenced to eat out their galleries. At the end of the month some of these latter were already two-thirds grown both in the Kachugaon forests and in the Rajabhatkhowa sál areas. This is as far as the life history has been carried. I am of opinion that it will be found that the insect has at least five generations in the year, the beetles of the second appearing the first or second week of June; those of a third at the end of July; a fourth in the middle of September; and a fifth towards the end of October. It is the grubs and the beetles of this last generation which hibernate and egg-lay in the following March. As soon as the first snap of cold makes itself felt, the grubs will leave off feeding and remain in a comatose condition in their galleries. The beetles which have already issued probably do as their Northern India ally does, bore into the thick bark of sál-trees and hibernate in this. It is not impossible that in the hot damp climate of Assam, in favourable seasons, the October beetles may pair and oviposit at once, and that a sixth generation may be passed through before the advent of a cooler temperature puts a stop to their work. The beetle tunnels into and feeds in green shoots of the sál in its mature state.

Damage Committed in the Forest.

This bark-borer must be ranked as second only to the *Hoplocerambyx* (p. 320) in its power of committing damage in the sál areas. It has not the latter's capacity for destroying the timber, since it never goes into it, merely grooving the outer sapwood. When numerous, however, it is equally as dangerous as a bast consumer, and probably more so, since it will attack young saplings. During its flighting periods it makes its appearance on newly felled trees as soon as the *Hoplocerambyx* beetle, and will enter the tree to oviposit in any part of it save the smallest twigs. In addition to attacking sickly standing trees in the forest it also makes attempts on healthy green standing trees. Several instances of this nature, in which trees had been attacked by the March generation of beetles or those of a generation of the past year, were noted: from the appearance of the galleries it is simple to fix approximately the period at which they were made. The trees in question responded with a copious outflow of sap which either drowned the beetles in their partially completed egg-galleries and killed the eggs and the young grubs, or drove the beetles from the tree to seek more favourable situations. Instances were seen where the beetle had maintained the struggle and laid its eggs, but it was noticeable that in these cases the egg-galleries were either longer, a small number of eggs only being laid which hatched into larvae which bored long galleries, the number being reduced to a dozen; or the egg-galleries were very short and narrow, the eggs being mostly laid on one side only, the larval galleries being small and short. The egg-galleries bored in such trees often curve (*vide* figs. *e*, *f*). Trees which had successfully resisted a bad attack by the February generation were, however, succumbing to that of the May one. A large tree, 5 ft. in girth and 100 ft. in height, the leaves of the upper part of the crown of which had but recently turned brown and withered, was felled in May and examined. It was found to have been unsuccessfully attacked in the manner above described by the March generation. The May one had better success, and the crown and upper one-third of the stem were full of beetles and grubs. No other cause for the dying condition of this tree could be found, although the upper portions of the roots were laid bare in search of a possible root fungus. The *Hoplocerambyx* had not yet appeared in the tree.

I have already alluded to the damage creepers do in these forests. They were cut over in the sál areas near Kachugaon (Polo and Hel Blocks) three years before my visit in 1906. It is possible that many of the trees attacked in these localities by these beetle pests may have formerly been partially strangled by the creepers, and thus had their vitality greatly reduced. Before they have been able to recover strength they have been attacked by the insects, with the deplorable results seen.

On two occasions in May I took in the Kachugaon Forest this beetle buried in a living shoot of a sál-pole, only the extremity of the body of the beetle being visible from outside. In each case the tree had been felled to examine it for other boring insects, and the *Sphaerotrypes* beetles

were in the upper branches in the crown of the tree. There can be little doubt that the beetle, as is the case with *Sphaerotrypes siwalikensis*, tunnels into green shoots for feeding purposes only, and in areas of coppice and young plantations would prove a serious pest in this connection.

Methods of Protection.

Methods for the protection of forests from the attacks of bark-boring pests of this nature have already been discussed when considering the life history of *Sphaerotrypes siwalikensis*, and it will be unnecessary to detail them again here. The method of ascertaining the numbers of the insects in the forest and of trapping them by using felled trees as described under *Hoplocerambyx* can also be resorted to in the case of this insect. In May the same trees will do for both, since at least one generation of the *Sphaerotrypes*, and probably the March one also, will coincide with the appearance of the *Hoplocerambyx* beetles in the forest. For the other periods only the trap trees should be destroyed, i.e. barked and the bark burnt (the timber is not affected by this insect), when the beetle is not on the wing in the forest, i.e. when the insect is in the bark and sapwood either as larvae, pupae, or immature beetles.

Predaceous Insects.

Niponius andrewesi, Lewis, (p. 102).—This insect was first taken in Assam in May 1906, when it was found preying upon the sál *Sphaerotrypes* described above. It has already been shown that it has a wide distribution throughout the country.

Life History.—The following are supplementary notes on the life history of the *Niponius* as observed in Assam in April and May:—

Larvae were taken in the galleries of the mature grubs of *Sphaerotrypes* in the Hultugaon forests at the end of April. On 14 May I took a specimen of the beetle in a partially complete egg-gallery of a *Sphaerotrypes*. The bark-boring beetles had apparently been eaten by it. On the 21st of the month I took a number of beetles engaged in devouring the bark-borers which were attacking the large green sál-tree mentioned on p. 484. In addition to searching out the bark-boring beetles I think the histerid also enters the egg-galleries for the purpose of laying its eggs close to those of the *Sphaerotrypes*. The pink grub is, however, very active, and does not appear to confine itself to any one set of larval galleries, since it is often found between the bast and sapwood worming its way on to neighbouring galleries remote from the one where it hatched out. The eggs of the *Niponius* do not hatch as soon as, or at the same time as, those of the bark-borer, since no young larvae were present in any of the egg-galleries and short larval galleries found so numerously in the latter half of May. The abundance of this insect is by no means yet satisfactorily settled. In the three localities I have found it in it has only been sparingly taken. This may, however, be easily accounted for by the fact that it is only to be found in the larval galleries of its host, from which it has to be laboriously cut out. I have rarely taken

it on the bark of the tree. It apparently hides until it can safely enter a tunnel already extending down to the bast layer.

This insect is of such importance that the remainder of its life history urgently requires working out. We require to know whether the number of generations it passes through coincide with those of the *Sphaerotrypes*, and the exact number of them. The larval and pupal stages and beetle stages of the first generation of the year, March to May, would appear to coincide with those of the insect it preys upon, and it is not unlikely that the remaining life cycles of the year will be found to do so.

Tilliœra assamensis, Stebbing, sp. nov. (p. 187). The beetle feeds on the mature forms of the *Sphaerotrypes* and also of *Platypus curtus* (p. 624), and on species of *Diapus* (p. 630).

FIG. 319.
Tilliœra assamensis, Steb., predaceous upon *Sphaerotrypes assamensis*. Goalpara, Assam.

Beetle.—Squarish, with an ant-like vertical head and "shoulders" to the elytra, which give it some superficial resemblance to a longicorn beetle. Black, with transverse white bands on the elytra. Antennae knobbed. Head black, shining, a few scattered black bristles on vertex, the front being set with close long white hairs. Eyes black, prominent. Thorax red, shining, with a deep transverse depression across the middle, and a marked channel just above the basal margin. Clothed with scattered stiff long black bristles, a bunch of white ones projecting from the lateral margins just above the base. Elytra black, set with rough scales. A band of white pubescence, under which the elytra are yellowish red, starts from the base on either side of the median suture and is produced upwards for about a third, when it expands laterally to the outer edges in the form of a broad transverse white band whose apical margin is produced medianly into a sharp point reaching to the upper third of the elytra. A second narrower white transverse band traverses the elytra just above the apices, which are black, clothed with more sparsely set white hairs. Under-surface black, the thoracic segments clothed with long thick spiny white hairs, most numerous laterally. Upper portions of femora yellow, rest of leg black, clothed with long yellow and white hairs Antennae yellow. Length, 6.5 mm.

The smaller size and position of the white bands on elytra easily distinguish this insect from *Thanasimus himalayensis*.

Life History.—This insect was first taken on the wing whilst I was proceeding through the Hultugaon forests on an elephant. It was subsequently caught flying round and running about on the bark of newly felled sál-trees in the Kachugaon (Polo and Hel blocks) forests. It is an extremely active insect, resembling a *Cicindela* in its movements, as it flies and runs with great rapidity. Beetles were kept for some days and fed with living *Sphaerotrypes*, *Platypus*, and *Diapus* beetles. They were found to consume a considerable number of the bark and wood beetles per day, taking about fifteen minutes to eat one *Sphaerotrypes* beetle. Their habits, method of feeding, etc., are similar to those described for *T. himalayensis* (p. 509). There is still a considerable amount of information required about this very useful insect. We need to find its grubs, which almost certainly feed upon the bark- and wood-boring scolytid

Section of stem of a sál (*Shorea robusta*) tree, showing entrance and exit holes of *Sphaerotrypes globulus* Blandford, on the outer bark. Mandla, Central Provinces, April 1909.

grubs; also to discover where the eggs are laid, and whether the generations of the beetle coincide with those of its hosts.

Platysoma sp. (p. 106).—This histerid is predaceous upon the *Sphaerotrypes*.

Beetle.—A compact, shining, black beetle, squarish in build, with a hard integument: elongate, pointed mandibles. Head and thorax very smooth and shining. Elytra smooth, shining, with a few longitudinal striae placed wide apart. They leave the last two segments of the abdomen exposed, the last being constricted behind. These segments are thickly and deeply punctate. Length, 6.5 mm.

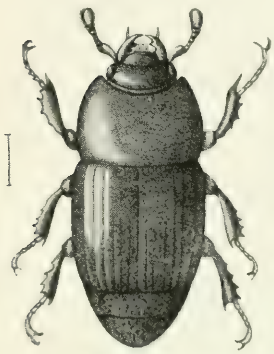


FIG. 320.
Platysoma sp., predaceous upon *Sphaerotrypes assamensis*, Steb. Goalpara.

Life History.—Only a few specimens were taken. They were found beneath the bark of the sál-tree felled on 13 May in the Kachugaon forests which was subsequently infested by the bark-borer. The histerid attacks the *Sphaerotrypes* beetles, and their grubs probably feed upon the larvae also.

Use in the Forest.—These two insects are of considerable use, provided they exist in sufficient abundance to exercise a salutary check on the bark-boring pest. This I have not yet ascertained. Any insect predaceous upon a pest is, however, of great value, and the life history of the *Platysoma* requires working out. The number of generations in the year, period passed in larval stage, and food eaten by larvae, etc., all require to be studied.

Sphaerotrypes globulus, Blandford.

REFERENCE.—Blandf. *Trans. Ent. Soc. Lond.* 63 (1894).

Habitat.—Central Provinces Sál Forests.

Trees Attacked.—Sál (*Shorea robusta*); *Terminalia tomentosa*. Mandla, Central Provinces.

Description.

Beetle.—Squat, ovate, black, elytra black with a suggestion of a dark reddish tinge, under-surface with a silvery pubescence; antennae orange, legs dark red. Vertex of head reticulate and punctate, more punctate laterally, front reticulate-punctate, with a short median longitudinal raised line reaching from level of base of eyes to near lower margin of front, in other cases stretching to about level of middle of eyes; a semicircular fringe of whitish hairs stretches along anterior edge of vertex between eyes. Prothorax constricted in anterior portion and much depressed, the median line terminating anteriorly at the depressed part; surface finely reticulate and punctate, slightly shining, with fine short white setae, densest laterally. Elytra striate-punctate, the scales black, large, and prominent, intervals smooth and finely punctate. Under-surface with lateral portions of thorax and anterior abdominal segments reticulate and clothed with a rather dense short silvery pubescence; the legs clothed with same silvery pubescence. Length, 2.6 mm. to 3.2 mm.

FIG. 321.
Sphaerotrypes globulus, Blandford. Central Provinces.

Life History.

This *Sphaerotrypes* infests the sál and *Terminalia tomentosa* of the Central Provinces and Chota Nagpur sál areas, and takes the place of the *S. siwalikensis* in the United Provinces and the *assamensis* in Assam. Its method of attack in the tree, plan of galleries, and life history are very similar to those of these two latter insects, with some points of difference due to climatic peculiarities of its environment.

The first beetles of the year make their appearance in February, and oviposit in felled trees, wind-blows, or in standing green sickly or dying trees in the forest. The male beetle fertilizes the female inside the tree. The male bores through the bark down to the sapwood, and eats out there a short gallery from a third to a half of an inch in length, and parallel to the longitudinal axis of the tree. A female enters by the entrance-hole of the male in the bark (enlarging it, as the female is larger than the male), is fertilized in the small tunnel in the sapwood, and then proceeds to eat out a prolongation of this pairing-chamber, the direction remaining the same. On either side she eats out small indentations, in each of which an egg is placed. The development of larvae is similar to that of the other *Sphaerotrypes* beetles known, save that the larval galleries appear to be of shorter length. The larvae, when full-fed, appear invariably to pupate in the bark, eating out a cup-shaped depression in the thick bark at the end of their galleries.

The number of eggs laid is from twenty-five to thirty on each side, fifty to sixty in all per female. The length of the egg-gallery is from just under 1 in. to $1\frac{1}{4}$ in. It is shorter when made low down in the main stem than when made in the smaller branches. The larval gallery is from 2 in. to $2\frac{1}{2}$ in. in length. The pattern left by the egg and larval galleries in the bark is similar to that left by *siwalikensis*, and is shown in pl. xliv.

We have seen that a generation of beetles appears in February and oviposits. The beetles maturing from these eggs appear in April, giving seven to eight weeks for the generation, and may be found laying the eggs of the second generation of the year in the latter half of April. The number of generations in the year has not yet been definitely ascertained, but it will not be less than four.

The life history, as detailed above, shows that the insect is a generation ahead of *siwalikensis* in April, since the first beetles of the year of the latter only appear in this month, the long cold winter in the north accounting for the difference.

The life history of the insect in the *Terminalia tomentosa* is similar to that in the sál. Owing to the bark of this tree being somewhat thinner, to its drying quicker, and to its being whiter inside, the galleries of the insect are more clearly defined than in the sál. (Cf. plates xlii and xliv.)

Damage Committed in the Forest.

I first noticed the attacks of this insect in the Chota Nagpur sál forests between the years 1894 and 1897. In 1909 I had an opportunity of studying its life history in the Mandla division of the Central Provinces. My visit was at an opportune time, since, in addition to the cold-weather fellings, a new road

Section of stem of a sál (*Shorea robusta*) tree showing the egg and larval galleries of *Sphaerotrypes globulus*, Blandford, on the outer sapwood. Mandla, Central Provinces, April 1909.

was being driven through a portion of the fine sál forests, and a considerable number of sál-trees had been felled on the line, of which some still remained lying unbarked in the forest. Scarcely one of these trees (sál and *Terminalia*) had escaped the attacks of this insect, and nearly the whole of the logs and brushwood left from the cold-weather fellings had bred out a generation of the beetle. Trees felled in January were at once tunnelled into by the beetles which appeared on the wing in the forest in February; and those which were not too dry or had been felled at a later date were infested by the generation of beetles issuing in April In this latter month the beetles were swarming in large numbers in the forest wherever newly felled trees were situated or where standing dying trees were to be found. I collected with ease over a hundred beetles in under half an hour.

I had felled several large trees which had a sickly appearance or had newly dead leaves hanging on them. In one of the former I found the upper part of the main stem, the upper fourth, and all the branches pitted with the entrance-holes of this beetle. A careful investigation, however, showed that although in some instances the beetles had got down to the sapwood and even commenced the egg-gallery they had almost invariably given up the attempt and left the tree. I explained this action as due: (1) to the vitality of the tree still being considerable, and to its being able therefore to respond to the attack with a strong flow of sap; (2) to the extra heavy fellings in the neighbourhood offering abundance of trees in the condition preferred by the beetles for ovipositing purposes. Many of these trees had only been felled a couple of weeks before my arrival.

Another tree felled, on which the dead yellow leaves were still hanging, had been heavily infested by the beetle in its upper third. The bark of this portion on both main stem and branches was pin-holed with thousands of the entrance and exit holes of this insect, the matured beetles having left the tree to oviposit elsewhere. The lower portion of the stem of the tree was still full of sap and quite green, and the generation of beetles now on the wing in the forest were tunnelling into it to oviposit. This tree had undoubtedly been killed by the beetle, and was a proof that the insect will attack standing trees in the forest should they become sickly. The lower portion of the bole was infested by the *Hoplocerambyx spinicornis* beetle, the cerambyx and scolytid working together in this area.

Protection and Remedial Measures.

Methods for dealing with insects of this nature have been already described under *siwalikensis*. I noticed here the powerful effect of the hot-weather sun. In one of the badly infested *Terminalia tomentosa* felled trees the stem had been logged and one of the logs rolled on to the edge of the road, where it lay exposed to the full sun's rays, the side attacked by the beetle, which had previously been in the shade, being now exposed. On stripping off the bark the insect was seen in various stages of partly grown larvae, fully grown ones, pupae, and immature beetles. In every case, however, the insects were dead, having been literally roasted to death under the powerful

rays of the sun, and this in spite of the fact that the bark still remained on the tree. This is sufficient proof that in the plains of India the mere barking of infested trees will be sufficient to kill off the insect provided it has not reached the mature-beetle stage.

Parasitic and Predaceous Insects.

Ichneumon ? sp.—I took three cocoons of an Ichneumon or Bracon fly in the pupal chambers of the *Sphaerotrypes*, but was unable to breed out flies from them.

Niponius andrewesi.—I took specimens of the larvae, pupae, and mature beetles of this insect infesting the *Sphaerotrypes*. The insect has already been fully dealt with under *S. siwalikensis*. A point of interest about the larva is that it will devour its own kind in the absence of other food, and that it also devours the *Sphaerotrypes* pupae. This I was able to prove by keeping specimens together in a glass tube. The beetle is to be found on the wing at the same time as the bark-borer.

Sphaerotrypes coimbatorensis, Stebbing.

REFERENCES.—Stebbing, *Ind. For. Mem.* Zool. Ser. vol. i, pt. i, 4; id. *Depart. Notes*, i, 395.

Habitat.—Coimbatore District, Madras Presidency.

Tree Attacked.—*Anogeissus latifolia*. Anamalai Forests, Coimbatore.

Description.

Beetle.—Small, globular, constricted behind. Black. Head black, depressed below forehead, rugose. Two elongate golden yellow brushes of hair project from the gula to the mouth. Prothorax constricted in front, the greatest width two-thirds down, anterior margin elevate, with a transverse prominent depression behind it; posterior margin produced backwards medianly into an elongate point; surface coarsely reticulate in basal portion, finely so anteriorly; a longitudinal median elevate line, often not very prominent, a few short yellow bristles in transverse anterior depression, and on posterior part of elevate median line. Elytra with basal margins convexly rounded and minutely serrate, constricted behind with apex angled; the last segment of the body exposed; broadly striate, the interstrial portions set with small sharp elevations, much smaller than in *siwalikensis*; the striae do not reach the basal margin, which is coarsely rugose, and curve backwards to meet in apical margin. Elytra set with a short, stiff, sparse pubescence, more abundant apically. Under-surface slightly convex, black; abdominal segments set with short, sparse, whitish bristles; legs black, tarsi yellowish. Length, 2.5 mm. to 3 mm.

The golden yellow brushes of hair on under-side of head are sufficient to distinguish the species from other known Indian ones.

Larva.—When first hatched the larvae are tiny white legless grubs, very convex dorsally, and slightly so beneath.

FIG. 322.

Beetle and young larva of *Sphaerotrypes coimbatorensis*, Steb., in *Anogeissus latifolia*. Coimbatore, Madras.

Life History.

To oviposit the beetle tunnels through the bark of the tree down to the cambium. This entrance-tunnel is made by one beetle only, whether by the female or male has yet to be observed. On reaching the bast a gallery about a quarter of an inch long, with parallel

sides, is grooved out, and in this two beetles, a male and female, are always to be found; and this is probably the pairing-chamber. After pairing the male leaves the chamber by the hole of entrance, and the female commences boring her egg-gallery. This is merely a straight continuation of the pairing-chamber, and is always parallel to the longitudinal axis of the tree. Small recesses are eaten out on either side close together all up this gallery, and an egg laid in each. The first eggs hatch out before the female has completed her gallery and egg-laying, so the egg-stage is evidently a short one—lasting but a few days at most. The female blocks up each recess with wood-dust after laying an egg in it, probably to provide a first meal for the newly hatched larva. The egg-gallery is kept quite free of wood-dust. An examination of old galleries will show that the larvae bore away from the egg-gallery in a radiating manner, the pattern formed by their collective galleries approaching an ellipse. When full-fed the larvae enlarge the end of their galleries and pupate in these chambers. When mature the beetle bores its way straight out of the tree by a hole through the bark. The length of the egg-gallery is five-eighths of an inch to two inches, with a breadth of a quarter of an inch or less. Length of larval galleries one-third to one and a quarter inch. Breadth one-eighth inch at top and one-sixteenth inch at base, where they take off from egg-gallery. The number of eggs laid by the beetle averages twenty-four. The plan of the gallery is very like that of *S. siwalikensis*, shown in fig. 19.

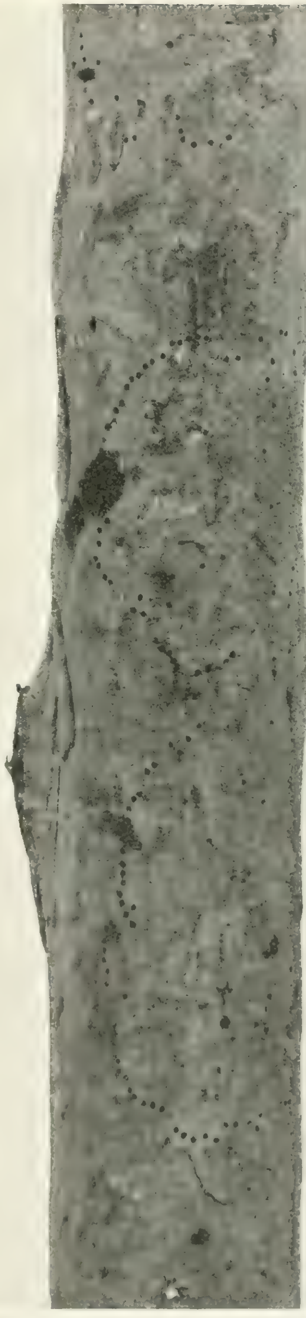


FIG. 323.—*Anogeissus latifolia* pole infested by *Sphaerotrypes coimbatorensis*, Steb., showing the exit-holes of a matured generation of beetles. Coimbatore, Madras. August 1902.

I consider it probable that there are at least three generations of this beetle in the year—and perhaps four. Some green *Anogeissus* poles felled in April and left lying in the forest were examined on 6 August. They were found to have been attacked from top to bottom by this beetle since they had been felled. The insects had laid their eggs in

the felled poles, the larvae had hatched out, become full-fed, pupated, and emerged as beetles. All this was plainly decipherable; but the examination showed that, whilst the work was evidently so recent as to have been done during the year, it was not fresh enough to have been that of the beetles then swarming in the forest. The exit-holes made by the beetles had had time to dry and shrivel round their edges, and the boring was no longer fresh and clean. It is probable that the poles were attacked in April, soon after being felled, and eggs laid in them. The beetles maturing from these eggs issued some time in June, and at once laid eggs in other trees, the poles in which they themselves had matured having become too dry to afford food of the nature required by the larvae. These would be the eggs of the second generation, and beetles from them would appear in August. This theory was entirely supported by finding beetles and larvae in some newly felled poles on the 6th of that month. The insects had settled upon these poles, which were unbarked, in a swarm, and the bark was pitted with their entrance-holes. Beneath they were to be found in various stages of egg-laying. In some cases but one beetle was present, having just bored down to the cambium layer. In others two were to be found in the chamber, whilst in others again the egg-gallery had been commenced, or was partially complete, the eggs first laid (at the bottom end) having already hatched out. These beetles were evidently not those of the generation which had attacked the April poles, since they had obviously but just left the tree in which they had matured, and we have seen that the exit-holes in the April poles had dried-up edges. I therefore conclude that they belonged to an intermediate generation, probably the second of the year, and were laying the eggs of a third.

The beetles evidently leave the trees together when mature, and fly off in a swarm in search of trees in a condition suitable for egg-laying.

Relations to the Forest.

As far as observations have been carried, it would appear that this beetle is capable of making itself felt as a serious pest in the forest. It has evidently the power of swarming in considerable numbers, and requires fresh bark in which to lay its eggs. At present it has only been found in newly felled poles, but it is more than probable that it would attack young growing saplings, especially sickly ones, were the former not available. Poles inspected, which had been attacked by the insect, and which the beetles on maturing had left, were found to have their bast layer completely riddled by the pest, whilst the bark externally showed, in addition to the entrance-holes, numerous elliptical rings of exit-holes placed close to one another, as shown in fig. 323. An examination showed me that this insect appears to be fairly free from parasites, as a close inspection failed to disclose any larval remains in the larval galleries and pupating-chambers. In the cases where larvae have been attacked it is generally possible to find at least the skin of the head and perhaps a portion of the thorax and abdomen present in the pupal chamber or larval gallery. Further, the holes in the

elliptical ring on the bark usually corresponded in number with the larval galleries on the inner side of the bark and in the sapwood. Further observations are required on this point.

Previous to finding this insect I saw in the Coimbatore Forest Museum a portion of an *Anogeissus* post marked "attacked by insects." The post showed a series of plans of the old egg and larval galleries evidently caused by a scolytid insect. They resembled closely the ones described here, and the post had probably been attacked in the forest by this beetle.

Protection and Remedies.

Newly cut poles should be at once removed from the forest or barked. If neither is possible, and a stream is close by, they should be put into this for a couple of weeks. This will probably be sufficient to render the bark distasteful to the insects. In the case above described the trees had been cut for road-making purposes. Care should be taken to see that poles cut in excess of the requirements are not left unbarked in the forest, as was the case in this instance. The last part of April and first half of May, the last half of July and the first half of August, are probably the flight times of the beetle, i.e. the egg-laying periods, with perhaps the middle portion of September if there is a third, or portion of a third, generation, which is probable. It is quite possible that the eggs of the first generation of the year may be laid in February. The April generation would then be the second one of the year.

In plantations, coppice areas, etc., all infested trees should be at once cut out and either barked, if this is possible, or burnt. The periods for treating the plantations would be the three weeks succeeding the completion of egg-laying in the different generations.

Predaceous Insect.

Niponius andrewesi.—This *Niponius*, already described under the sál-tree *Sphaerotrypes*, is also predaceous upon this species. I took mature specimens of the beetle in the tunnels made by the bark-borer in *Anogeissus* in August. The beetles were probably engaged in laying their eggs in the egg-galleries of the *Sphaerotrypes*.

Sphaerotrypes querci, Stebbing.

REFERENCES—Stebbing, *Ind. For. Mem.* Zool. Ser. vol. i, pt. i, 5 (1908); id. Ins. Pes. Himal. Oaks, *Ind. For. Records*, vol. ii, pt. i, 19 (1909).

Habitat.—Kumaun, North-West Himalaya.

Tree Attacked.—Moru Oak (*Quercus dilatata*). Naini Tal.

Description.

Beetle.—Short, oval, very convex. Black, with antennae slightly lighter and tarsi ferruginous. Head punctate, more strongly so at sides, hairy at vertex. Prothorax one and a half times as broad as long, base bordered and produced backward to form an obtuse angle, the angle truncate, concave on either side, emarginate anteriorly, and sides rounded and narrowed anteriorly, a narrow elevated line down centre more prominent and shining at base and not reaching to anterior margin; coarsely and somewhat closely rugose; a few stout bristles, yellow in colour, on anterior outer margin. Scutellum squarish, oblong, punctate. Elytra slightly wider than

thorax, not quite twice as long as latter, conjointly emarginate at base, basal borders crenate, basal angles strongly rounded and sides rounded from base to apex. Almost black, with a dull reddish tinge on them; striate, the striae deep and prominent, but not reaching to base of elytra, shining, flat with scattered punctures, the interstices slightly elevate and convex, coarsely rugose-punctate. Under-surface black, with a scattered yellow pubescence; abdominal segments 1 and 5 large and equal to one another, 2, 3, and 4 much narrower, punctate with sparse yellow hairs on them. Length, 3 mm. (Figs. 2, *2a*, pl. xlv, show a dorsal and side view of this beetle.)

Larva.—Small, white, oval. Very convex above, and much corrugated and channelled. Length, 4 mm. (fig. 1).

Life History.

Very little is known upon the subject of the life history of this bark-borer. I took nearly full-grown larvae in their galleries in the tree towards the end of May 1908, these being the larvae of the first generation of the year. The beetles mature about the first or second week in June. The number of generations of the insect in the year has yet to be ascertained. It is possible that it has at least three life-cycles in a season. It is important that this fact should be definitely and accurately determined. Fig. 3 in pl. xlv shows a diagrammatic view of the egg and larval tunnels made in the sapwood and bast by this insect. The damage it is capable of doing to the tree and the methods of combating its attacks are similar to those detailed for the *Dryocoetes* bark-borer (p. 548) of this oak.

Sphaerotrypes macmahoni, Stebbing.

REFERENCE—Stebbing, *Ind. For. Mem.* Zool. Ser. vol. i, pt. ii, 16 (1909).

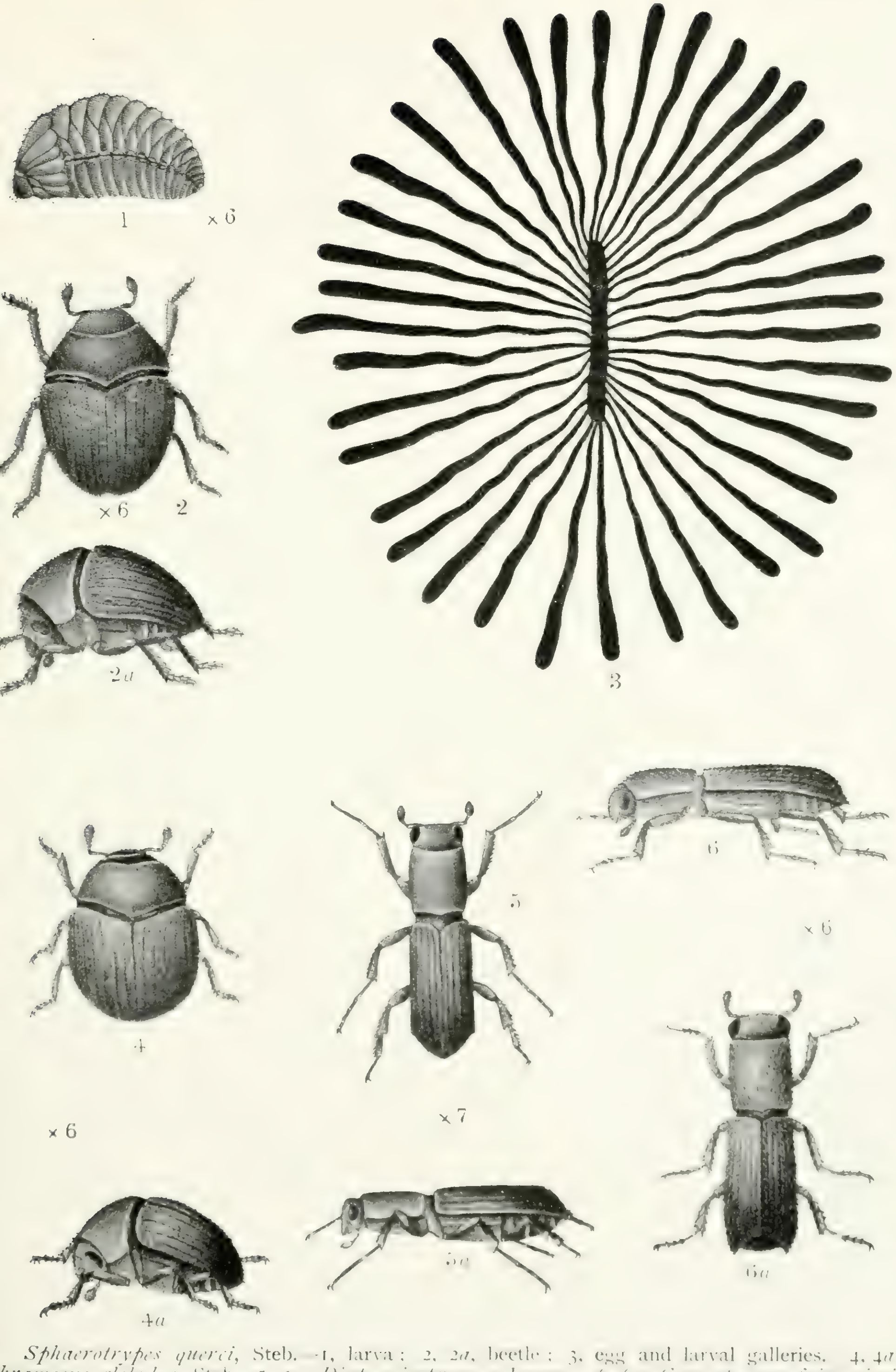
Habitat.—Suliman Mountains, Baluchistan, and Dehra Ismail Khan.

Tree Attacked.—Olive (*Olea cuspidata*). Sangar Scallon, Suliman Mountains (Elev. approx. 7,000 ft.).

Description.

Beetle.—Elongate, globular, very convex above. Dull black or brownish black. Easily distinguished by the presence of what appears to the naked eye as an X-shaped marking of whitish-grey pubescence, the upper arms (which coincide with basal margin of elytra) and lower arms (which are situated a little below middle of elytra) of the X being short, and the vertical portion of the letter elongate. The flat front of the head, the under-side of the thorax, and the abdominal segments densely clothed with a short dense grey pubescence. Prothorax punctate, the longitudinal median line fairly prominent and ending in a raised elevation behind. Rather densely covered with longish grey hairs, shorter and less dense on disk; the posterior margin thickly set with a short very dense greyish pubescence which forms the upper arms of the letter X. Elytra slightly wider than thorax, not twice as long. Easily distinguishable from the other four Indian species I have described by the finer striae, the interstrial spaces much more finely rugose and covered with a fine short stiff grey-brown or black pubescence. The basal third of the suture is set with a very dense short grey pubescence which curves outwards and downwards from a point about a third up the suture from the base, forming a grey band which reaches the outer margins two-thirds up from the base (forming the vertical portion and the lower arms of the X). The outer shoulders as also the apical portion of the elytra are also set with this grey pubescence. Under-surface covered with a dense yellow-grey pubescence. Antennae and legs reddish brown, moderately clothed with a greyish pubescence. Length, 2.75 mm. to 3.20 mm.

Larva.—Elongate, convex, and corrugated above, oval, flat beneath, but slightly curved and yellowish pink in colour.



Sphaerotrypes querci, Steb.—1, larva; 2, 2*a*, beetle; 3, egg and larval galleries. 4, 4*a*. *hramesus globulus*, Steb. 5, 5*a*. *Diapus impressus*, Janson. 6, 6*a*. *Crossotarsus fairmairei*, hap., var. *wilmoti*, Steb.

Life History. This beetle infests the olive (*Olea cuspidata*) in North Baluchistan and possibly neighbouring tracts. I found a living tree badly infested by the insects on 9 November 1905, the females being engaged in eating out elongate vertical egg-galleries some two inches in length transversely across the tree instead of parallel to the longitudinal axis as is the general rule of the Indian species of the genus, and laying the eggs in small indentations on either side all the way up. The larvae eat out wavy galleries some two and a half inches in length, making the usual *Sphaerotrypes* pattern in the wood. I know nothing further about the life history of this insect.

Sphaerotrypes sp.

Habitat.—Salween River, Tenasserim.

Tree Attacked. — *Terminalia tomentosa*. Kowloon Island, Salween River.

Beetle.—Smaller than *S. siwalikensis*. The beetles taken were in too poor a condition to render the determination of the species possible.

Life History. I took two individuals of this *Sphaerotrypes* from their egg-galleries in the bark and sapwood on 9 March 1905. The knife unfortunately inadvertently cut through one of them, and the other was in a poor state of preservation. They were, however, easily identified as a species of *Sphaerotrypes*.

The beetles taken were dead mother beetles, the generation arising from the eggs laid by them having left the tree in all probability during the previous autumn. A generation of the *Xylotrechus* of this tree (see p. 353) was just maturing and leaving the tree, a large standing nearly dead one.

The egg-gallery of this species of *Sphaerotrypes* is much shorter than that of the *siwalikensis* of the sál, and fewer eggs are laid. In the galleries I examined only four to six larval galleries took off from the egg-gallery,

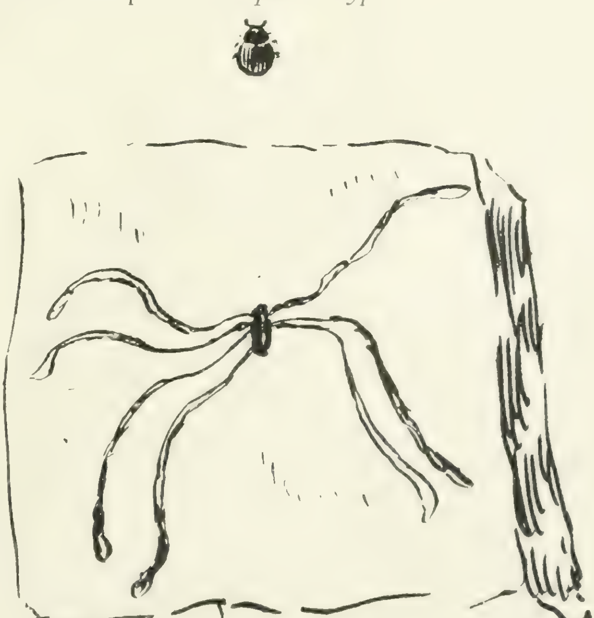


FIG. 324.—Egg and larval tunnels of *Sphaerotrypes* sp. in the inner bark of *Terminalia tomentosa*. The beetle is shown above the bark. Salween, Tenasserim. (E. P. S.

but the insect had tunnelled into the thick bark of the base of the tree, which was almost as hard as wood, the gallery being either in the sapwood and bark or entirely in the bark. The difficulty experienced by the beetle in making its egg-gallery may have been a reason for the few eggs laid. I also found evidences of the work of this beetle in this tree at Wutgyi, the matured beetles having already left a tree in which the *Xylotrechus* was just maturing.

I have no further notes on the life history of this insect. It is interesting to find that the genus extends into Burma.

Phloeosinus.

Phloeosinus zhobi, Stebbing.

References.—Stebbing, *Ind. For. Mem.* Zool. Ser. i, pt. ii, p. 6; id. Chilgoza Bark-Bor. Beet. Zhob, *Ind. For. Bull.* no. 3, p. 13 (1905).

Habitat.—Zhob, Dera Ismail Khan (Suliman Mountains).

Tree Attacked.—Chilgoza Pine (*Pinus gerardiana*). Shinghar, Zhob; Takht-i-Suliman.

Description.

Beetle.—♀ Oblong, cylindrical, black, the thorax and elytra with at times a reddish tinge. Head black, finely and closely pitted, sparsely covered with a few fine short white hairs. Eyes reniform, with the anterior margins straight. Antennae yellow, funiculus four-jointed and club with four articulations. Thorax constricted in front at upper third, finely and densely pitted, with a sparse white pubescence over it. Elytra striate-punctate, with a row of deep punctures down the striae, the intervals being convex with fine punctures; in apical fourth the large punctures disappear and the striae are very faint; the apex is set with spiky protuberances or teeth which extend laterally up the sides; the elytra are covered with a scattered white pubescence denser at sides and in apical portion. Under-surface black, with long stiff sparse hairs; finely pitted. Abdominal segments narrow. Legs reddish brown, covered with sparse yellow hairs; tarsi yellow; tibae armed with four teeth on outer edge and terminating in a longer tooth on inner upper edge. Length, 1.9 mm. ♂ smaller than ♀, elytra reddish, the white pubescence being absent. Apex of elytra with fewer teeth. Length, 1.5 mm. Pl. xlviii, figs. 2*a* and 2*d*, shows dorsal and side views of the female and male beetles.

Egg.—Blunt elliptical in shape, white and translucent (see fig. 2).

Life History.

This small beetle was found accompanying *Polygraphus trenchi* (p. 510) in its attacks on chilgoza-trees in North Zhob in 1905. Although by itself perhaps not so serious a pest as the latter, it nevertheless occurs in considerable numbers in the trees. A noticeable fact about this insect, and one perhaps not without importance, is that it will attack and lay eggs in trees which have become too dry for the *Polygraphus*. I do not mean that the trees are dead ones. Neither beetle will touch a dead tree, but the *Phloeosinus* will lay eggs in trees in which a generation of the *Polygraphus* is just maturing and emerging, although none of these latter insects will oviposit in the tree, the bark having become too dry to yield the necessary food for their larvae. As an example of this, tree No. 3 (see p. 512) may be instanced. Here the *Polygraphus* was found in all stages of full-grown larvae, pupae, and immature and mature beetles;

the mature beetles were issuing from the tree, but there were no fresh egg-galleries or eggs. On the other hand a large number of mature *Phloeosinus* beetles had bored into the tree within the last week (between 14 and 20 June) and laid their eggs in galleries grooved out in the bast. The insects were also tunnelling into the green tree No. 4.

This insect probably commences operations in the spring, laying the first batch of eggs of the year towards the beginning of May. In the trees, however, I found only (1) mature beetles boring in in every instance to lay the eggs of what I think was the second generation of the year, (2) eggs laid by these latter, and in some cases (3) small larvae hatched from these eggs which had already begun to bore away from the egg-tunnel. As in the case of the *Polygraphus*, the male insect appears to be the first to bore into the tree and commence hollowing out a chamber which grooves the sapwood more or less deeply. He is soon followed by a female and this latter by another till as many as four female beetles may have joined the male, all five being found together, at this stage, in what is apparently an enlarged pairing-chamber. From this the females, after pairing with the male, eat out each a long clean irregularly curving egg-gallery, and lay large eggs in depressions gnawed out at the sides, one in each. These depressions are at fairly wide intervals apart, ten to twelve eggs being laid, about half on each side of the gallery. These galleries are chiefly in the bast, although they occasionally groove the sapwood. Fig. 22 shows a piece of bark with the pairing-chamber, egg-galleries, and recess in which the eggs are laid. From the eggs young larvae hatch out in a few days, and then bore away from the egg-gallery more or less at right angles to it. As I have taken only young larvae I do not know how long these galleries are, nor where the larvae pupate, whether in the bark or wood. The irregular winding galleries giving off all round form a figure which is usually more or less circular in general shape, and is easily distinguishable from the *Polygraphus* galleries, to which it has no resemblance whatsoever. The egg-galleries are also much narrower and smaller. The pairing-chamber averages an eighth of an inch across, whilst the egg-galleries are from one and a quarter to one and a half inches in length measured round the curves. The beetles mostly mature together, and issue from the tree in a swarm. Such a swarm had evidently settled upon tree No. 3, some from it having overflowed probably to tree No. 4. Although there is not at present as much corroborative evidence available on the life history of this insect as was obtained in the case of its more dangerous confrère the *Polygraphus*, it is probable that the *Phloeosinus* runs through an identical number of generations; in fact, when a generation of mature beetles of the former insect is found egg-laying in the trees, search will probably show that there is a similar one of the latter at work. The fact that they prefer, however, drier bast, and the observations made in the forest, indicate that the *Polygraphus* is the first beetle to attack, its companion only coming in when the vitality of the tree has been lowered. As a general rule, there-

fore, it may be said that this insect, whilst preferring the bast layer in a drier but still living condition, will when pressed bore into and lay in green healthy trees. In the latter case it is evidently more easily killed by the resinous exudation than is the *Polygraphus*.

The damage done to the trees and the methods of preventing it, as also predaceous foes, are similar to those described under *Polygraphus trenchi* on p. 517.

Chramesus.

Chramesus globulus, Stebbing.

Reference.—*Chramesus?* sp. Stebbing, *Depart. Notes*, i, 409 (1906); id. Ins. Pests Himal. Oaks, *Ind. For. Rec.* ii, pt. 21 (1909).

Habitat.—Jaunsar, North-West Himalaya (5,000 to 5,500 ft.)

Tree Attacked.—Ban Oak (*Quercus incana*). Jaunsar.

Beetle.—Small, globular, very convex above, flat beneath, widest across middle. Head small, black, with a yellowish brush of hair on forehead. Prothorax black, pentangular in shape, anterior margin straight, slightly ridged with a transverse depression behind the ridge, posterior margin produced back into a median point. Elytra very convex, purplish or black in colour, striate, base rugose, the interstrial spaces with series of fine raised points; the striae curve inwards towards apex; surface set with a short yellowish pubescence. Under-surface flat, black; abdominal segments clothed with a short spiny yellow pubescence, denser laterally. Length, 3 mm. (Pl. xlv, figs. 4, 4*a*, shows a dorsal and side view of this beetle.)

Description.

Life History.

The beetle first appears on the wing in the spring about the first week in May at elevations of 5,000 to 5,500 ft.

It tunnels into the wood of newly dead or dying ban oaks for egg-laying purposes. The insect bores straight through the bark and into the sapwood, and then turns to one side or the other and carries its gallery right down into the heart-wood at an angle. These beetles lay the eggs of the first generation of the year.

This is all that is at present known on the life history of this beetle. It will not attack dry wood. The holes drilled in the wood are circular in section.

Tribe CRYPTURGINAE.

Tibiae never prolonged into a hook or process at outer angle. Head provided with a rostrum. Third tarsal joint simple, round. Pronotum uniformly sculptured.

The tribe includes the genus *Crypturgus* and the far more important *Polygraphus*, both containing forest species in the Himalayan region.

Crypturgus.

Colonel F. Winn Sampson considers the following two scolytids to be species of this genus, the first being *C. pusillus* of Europe, Japan, and North America. Dr. Hagedorn, to whom the insects were submitted, expressed the opinion that they represent a new genus close to *Crypturgus*. I have considered it sufficient for the purpose of this work to follow Colonel Sampson.

Crypturgus pusillus, Gyll.

REFERENCE.—Stebbing, *Depart. Notes* (*Polygraphus minimus*), i, 252.

Habitat.—North-West Himalaya.

Tree Attacked.—The Blue Pine (*Pinus excelsa*) ; Spruce (*Picea morinda*).

Beetle.—The beetle is very small, black, moderately shining, with elytra covered with scattered longish white hairs. Head small, vertical in front, with a very short rostrum.

Description. Antennae short ; scape thick, straight ; funiculus five-jointed ; club compact, flattened, ovate ; eyes oval. Prothorax cylindrical, narrower in front than behind, and uniformly pitted. Elytra fairly long, rounded at the posterior declivity, not wider than prothorax behind, pitted. Thighs of legs long-oval. Tibiae finely toothed on their external edge ; tarsus filiform, the first three joints of equal size, the third not bilobed. The three intermediate segments of the abdomen of same size and short. Antennae and legs yellowish brown. Length, 1.1 mm.

FIG. 325.
Crypturgus pusillus, Gyll. North-West Himalaya.

Larva.—The larva is a minute white curved grub.

Life History. This minute scolytid is very plentiful in the Western Himalaya, where it is to be found infesting both the blue pine and spruce. It only comes into the tree when the bark has commenced to dry, appearing at the time when a generation of the *Tomicus ribbentropi* is maturing and leaving the tree. The insect may often be found in company with *Polygraphus pini*. So far as observations go it only infests the main stem of the tree, and only appears in the inner bast. The male beetle tunnels through the bark of poles which have nearly reached their maximum height development, or into that of old trees, and eats out a pairing-chamber which is of considerable size, though it is mostly hidden by a thin layer of the inner bark. From this central chamber a number of tiny curving galleries take off and ramify, each of which is made by a female beetle. These egg-galleries are quite short, about half an inch in length ; they wind and curve about, and have a sharp hook-like bend at the end in which the eggs are laid (see fig. 326). Large areas of the inside bark are occupied by these curious tiny curving and winding galleries, where several pairing-chambers are situated near one another. The male appears to fertilize at least six female beetles, and the number may be greater. The patches have a rough resemblance to the plan of the egg and larval galleries of a *Scolytus* (*Eccoptogaster*) beetle, but are infinitely smaller.

FIG. 326.
Egg-galleries of *Crypturgus pusillus*, Gyll., in spruce. North-West Himalaya. (E.P.S.)

On hatching out the grubs feed side by side, prolonging the mother egg-gallery for a short distance.

This combined larval gallery does not usually pierce the innermost layer of the bark, a thin lamella of bark being left as a covering. If the bark is taken off the grubs are not seen. Very often a thin lamella of bark also hides the upper portion of the female egg-gallery.

Thus the plan of this small scolytid, which is by far the smallest of the known coniferous Scolytidae of the Western Himalaya, is easily distinguishable, although it must be borne in mind that the patch of galleries visible in the bark, which has a darker appearance than the rest of the inner bark, consists of a number of combined pairing-chambers and egg-galleries. The insect always selects areas of bark containing moisture in them, and will not infest absolutely dry bark.

The first beetles of the year appear about the middle of May, and oviposit at this period. In the third week of June these beetles mature from the eggs laid in May, and lay the eggs of a second generation of beetles, which appear some time in August. These lay the eggs which give rise to a third generation in October, and there may be a fourth, or partial fourth, generation.

Relations to the Forest.

As far as present observation goes it is difficult to estimate the damage, if any, done by this tiny scolytid to the tree, the more especially as it has not been taken in young saplings and poles. It comes in after the blue-pine *Tomicus*, and probably waits until that insect has undermined the vitality of the infested tree. It remains in the tree, however, longer, and will undoubtedly attack bast that is no longer fresh.

The protection and remedies will be the same as described for the blue-pine *Tomicus* and the *Polygraphus* beetles with which it is associated in the trees. In getting rid of them this beetle will be likewise killed off.

Crypturgus sp. nov. ?

Habitat.—North-West Himalaya.

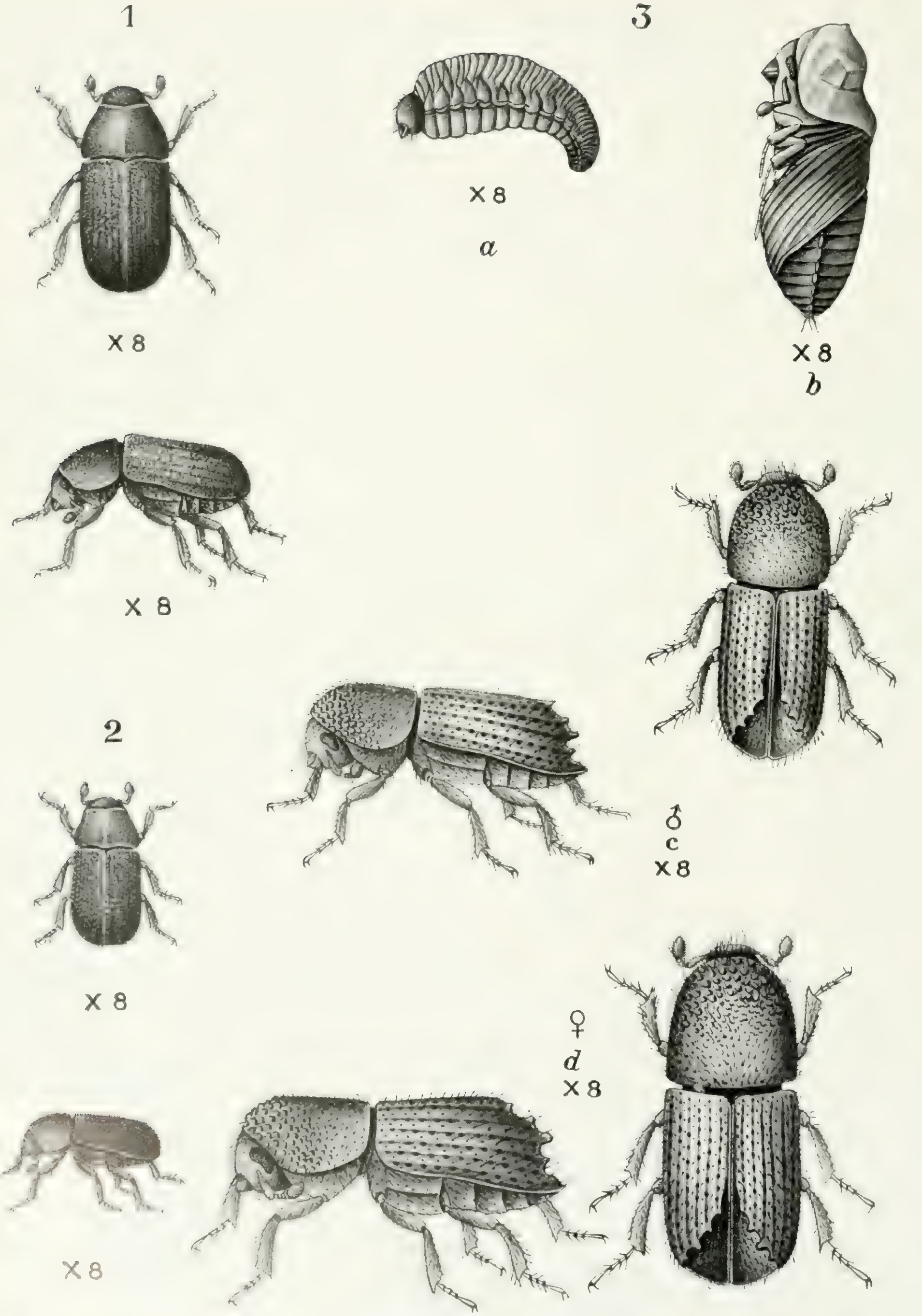
Tree Attacked.—*Pinus longifolia*. Jaunsar and Naini Tal, North-West Himalaya.

Beetle.—Smaller than the last; brown-black in colour; otherwise resembles *C. pusillus*. I am uncertain as yet whether this is a different species or not.

Fig. 327.
Crypturgus sp. nov. ?
North-West Himalaya.

Life History.

I first took specimens of this insect in the Tons Valley in Jaunsar in 1902. Subsequently I found the beetle in the Naini Tal forests. The insect attacks the tree when the sap has dried off to some extent. The plan of galleries is similar to that of *C. pusillus* in the blue pine and spruce.



1. *Polygraphus major*, Steb. 2. *Polygraphus pini*, Steb. 3. *Tomicus ribbentropi*, Steb.—*a*, larva; *b*, pupa; *c*, male; *d*, female beetles. North-West Himalaya.

Polygraphus.

An important genus containing several serious coniferous pests in the North-West Himalaya.

Polygraphus major, Stebbing.

(The Blue Pine Polygraphus.)

REFERENCES.—Stebbing, *Depart. Notes*, i, p. 234 (1903); id. *Ind. For. Mem.* Zool. Ser. vol. i, pt. 1, p. 6 (1908).

Habitat.—North-West Himalaya.

Trees Attacked.—Blue Pine (*Pinus excelsa*); Spruce (*Picea morinda*); Deodar (*Cedrus deodara*). Jaunsar, Simla, Kumaun, Tehri Garhwal, Chamba.

Description.

Beetle.— Oblong, sub-cylindrical. Head and prothorax black, shining. Elytra chestnut brown to black, covered with a short dense greyish or yellowish pubescence very characteristic of the beetle. Antennae yellow, club chestnut brown with a grey pubescence. Legs chestnut brown to black (more usually the latter), tarsi yellow. Head with an almost circular brush of longish yellow hirsute hairs on the front, the hairs pointing inwards; an irregular brush of similar hairs beneath the eyes and extending along the base of the mandibles. Prothorax sub-cylindrical, wider at the base than long, sharply constricted anteriorly; a fine median shining longitudinal carina variable in thickness and a narrow transverse channel in the anterior fourth, separating the anterior fourth, which is constricted, from the wider posterior portion; rugulose-punctate on disk and sides with the exception of a circular area on latter, which is smooth and finely punctate; the lateral edges and posterior outer angles coarsely rugose, with a short yellow pubescence which extends along posterior margin. Elytra twice as long as prothorax and two-thirds as wide as long, scarcely dilated towards apex; finely striate-punctate, the sutural stria most prominent, and others more prominent basally, disappearing apically; basal area rugose, the margin with a short dense whitish-yellow pubescence; this pubescence covers the whole of the elytra in living specimens, often giving them a greyish appearance; the basal and apical areas are often, however, found to be bare, the villosity having been worn off during the tunnelling operations of the beetle. Abdomen black, shining, punctate, the punctures densest on the apical segment; posterior edges of the segments fringed with yellow hairs, densest medianly. Length, 3.2 mm. to 3.8 mm. (Pl. xlvi, fig. 1.)

♂ Smaller than ♀, the prothorax more finely punctate, with a finer median carina, and the posterior angles more pubescent. Elytra with a finer punctation and finer pubescence. Length, 2.8 mm. to 3 mm.

Egg.—The egg is small, elliptical, with blunt ends; it is semi-translucent, the ends being quite translucent. Length, 0.75 mm.

Larva.—When newly hatched it is semi-translucent with a pale yellow head and yellowish-brown mandibles. The segments are marked dorsally, the abdomen tapering sharply. The full-grown larva is white, curved, legless, with a yellow head, followed by enlarged prothoracic segments. These and the abdominal segments, which taper posteriorly, are corrugated, soft, and bulky. Length, 3 mm.

Pupa.—Whitish yellow, broadest medianly, the head hidden by the thoracic hood; wings and legs pressed against the ventral surface.

Life History.

The beetle appears on the wing at the beginning of May at elevations of 8,000 feet, and during late April at lower altitudes, and may be found at these periods pairing and ovipositing in the trees. The insect appears to pass through the winter either as a mature beetle or as an over-wintering larva. If the

larva has pupated before the first cold of winter sets in it will probably be killed off during the winter months. The over-wintering beetles leave the trees about the third week in April, and commence ovipositing in the branches of old trees or in the main stem and thicker branches of seedlings, saplings, and small poles. The blue pine and spruce are the trees chiefly preferred, but the beetle also infests the deodar in areas where the former species are not in sufficient abundance.

The male beetle bores its way through the outer bark down to the bast, and in this and the sapwood eats out a chamber of irregular pattern, which is the pairing-chamber (fig. 328, *p*). Only parts of the tree covered with thin bark are selected by the beetle, and consequently this insect is never found in the

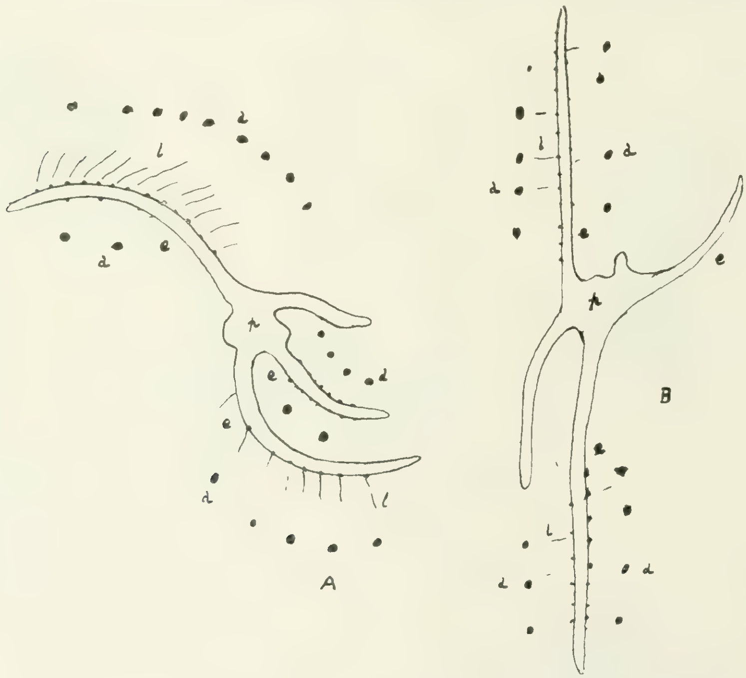


FIG. 328.—Plan of galleries of *Polygraphus major*, Steb., in the sapwood of blue pine. A, In the main stem of poles ; B, in the side branches, where the egg-tunnels are longer. The larval galleries only groove the wood faintly. *p*, Pairing-chamber ; *e*, egg-gallery ; *l*, larval gallery ; *d*, pupating-chambers in wood. North-West Himalaya. (E. P. S.)

main bole of the tree where it is covered by thick bark. This fact is one of considerable importance in the life history of and the damage done by this pest. Three female beetles (occasionally the number may be four or even five) successively enter the pairing-chamber through the tunnel made by the male (the first enlarging it slightly), and, after being fertilized by the male, proceed to excavate their egg-galleries. Each of the females eats out one such gallery (fig. *e*) and each takes a different direction to that taken by the

others. In this way the egg-gallery plans shown in figs. A and B are produced. These egg-galleries are bored deep in the bast and sapwood; they are usually curved and from 1 in. to $1\frac{1}{2}$ in. in length. The female, as she bores out her tunnel, gnaws out little notches at the side and places an egg in each. These notches are not made so symmetrically as in the case of the monogamous bark beetle, there being usually more on one side than on the other. From eight to fifteen eggs appear to be laid in each gallery (see fig. A). The first eggs hatch out before the female beetle has finished egg-laying, which process takes from four to six days.

The larvae, on hatching out, feed almost entirely in the bast and bark, and rarely groove the bast wood.

They bore winding galleries in a direction approximately at right angles to the egg-gallery, their tunnels averaging three-quarters to one inch in length. These tunnels are closely packed with the wood excreta passed out by the larvae in feeding. When full-fed, at the end of about four weeks, they eat out a small chamber in the sapwood (*d*) at the end of the larval gallery and change to pupae in this. When the pupa has matured into the beetle, in from eight to thirteen days, the latter bores its way out direct to the outside by a horizontal tunnel. Where the bark is of fair thickness the portion of the pupal chambers in the wood consists of merely a saucer-shaped depression. It is more usual, however, for the pupal chamber to be entirely hollowed out in the sapwood. From this method of feeding it will become apparent that, whilst the whole of the plan of the egg-galleries and larval galleries will be always visible in the bark, it is most usual to find in the sapwood a central chamber from which three

FIG. 329. Portion of a young blue pine (*Pinus excelsa* sapling showing entrance- and exit-holes of *Polygraphus major*, Steb., on outer bark. Jaunsar, North-West Himalaya.

or more arms take off, and at some distance from these arms irregular rows of small holes in the wood—the pupating-chambers of the grubs, whose tunnels were made entirely in the bast layer and are therefore not visible in the sapwood. This is the most characteristic appearance of stems and branches attacked by this pest, and by it the presence in the forest of the insect is easily recognizable. The egg-gallery is loosely packed with the wood particles eaten out in excavating it. When she has finished egg-laying the beetle bores a short offshoot gallery from the egg-gallery, in which she dies; or the female may die at the top of a prolongation of the egg-gallery, no eggs being laid in this portion. In small branches the beetle grooves the sapwood much more deeply, and the egg-galleries are usually much longer than in thicker ones.

This *Polygraphus* also infests the spruce in a manner very similar to that in which it attacks the blue pine. The number of generations passed through in the former tree, however, is fewer, owing to the greater elevation at which the fir lives.

I think also that this is one of the species of *Polygraphus* which infest the *Pinus gerardiana* in the Bashahr forests (Sutlej Valley).

Much more serious, however, than the attacks of the beetle on the spruce is the fact that in areas where the blue pine is scarce it infests the deodar and will attack young green trees, as was evidenced in Jaunsar in 1902, in the Simla Catchment Area in 1908, and in the Bré Forest in Chamba in 1909. The bark and wood of the deodar are very much harder than those of either the blue pine or spruce, and because of this a considerable difference is to be seen in the plan of the egg-galleries, for the number of the latter taking off from the pairing-chamber in the deodar is usually two only, and never more than three, and both the egg and larval galleries are shorter, as shown in pl. xlvii. In the deodar the periods occupied in passing through the several generations of the year appear to coincide more or less exactly with those of the deodar bark-borer (*Scolytus*, p. 568).

In favourable years, at the lower elevations at which the blue pine grows, this *Polygraphus* passes through four full generations and a partial fifth generation in the year. Ordinarily, however, the number of life-cycles during any one year may be taken at three full ones and a partial or wholly completed fourth generation, the periods occupied from egg to mature beetle being roughly from seven to eight weeks, as follows :—

Generation I.

3rd week in April	Eggs
4th week in April to end of May	Grubs
End of May to 3rd week in June	Nymphs
2nd week in June to end of June	Beetles

Generation II.

3rd week in June	Eggs
4th week in June to 4th week in July	Grubs
4th week in July to 2nd week in August . . .	Nymphs
1st week in August to 3rd week in August	Beetles

Egg and larval galleries of *Polygraphus major*, Steb., on inner surface of deodar bark. North-West Himalaya.

GENERATION III.

2nd week in August	Eggs
3rd week in August to 3rd week in September . . .	Grubs
3rd week in September to 2nd week in October . .	Nymphs
1st week in October to 3rd week in October . . .	Beetles

GENERATION IV (a complete generation).

Beginning of October	Eggs
1st week of October to 1st week in November . . .	Grubs
1st week in November to 3rd week in November . .	Nymphs
2nd week in November to 2nd and 3rd week in April .	Beetles

The November beetles will hibernate in the trees and lay the eggs of the first generation of the following year.

The exact time of the appearance of the various stages of the insect in these generations, and the number of life-cycles passed through, depend, of course, to a considerable extent on elevation, aspect, and climatic conditions, south and east aspects and a dry warm spring and summer following an open winter being most favourable. The generations will also be found to overlap to some extent.

Damage Committed in the Forest.

This insect confines its attacks to young growth and poles only, infesting trees which have not as yet acquired an outer layer of old dead bark. Owing to its polygamous habits it is capable of an even greater rapidity in increase than the deodar *Scolytus*, once conditions are favourable to it. For egg-laying purposes it undoubtedly has a preference for the blue pine, and next to the blue pine the spruce. It has been shown, however, that when these trees are scarce in a forest and the beetle is abundant it will oviposit in deodar, and this characteristic of the insect renders it a much more dangerous pest than would otherwise be the case at present.

It is of course possible that both blue pine and spruce may become more valuable commercially in the future should paper mills be established in the outer Himalaya. In such an event the capabilities of this insect of attacking and killing off young trees will have to be borne in mind. For the moment it is in areas of young deodar in which a few blue pine trees are present that the insect is a pest to be dreaded.

It is a more active beetle than the *Scolytus*, and flies by day and tunnels into trees in broad daylight and even in sunlight. It is not so sensitive to sunlight as its companion, and will tunnel into a tree or branch on almost any side. Poles, saplings, and quite young growth are alike infested, and it will tunnel into healthy green standing trees in the forest. The beetle appears endowed with a strong vitality, for it will almost invariably be found in some stage of its existence in felled green trees and green branchwood of the trees it affects, and is not so susceptible to their rapid drying as is the *Scolytus*. It spreads in a forest in a manner similar to that of the *Scolytus* beetles.

The following are extracts from a note relating to an insect attack published in the *Indian Forester* (vol. xiv, April 1888) under the title "Note on Insect Ravages in Pine Forests," by G. G. M. The insect I identify as this *Polygraphus*. G. G. M. wrote:—

The study and prevention of disease in forest trees is of such great importance, and so intimately connected with the prosperity of the forests, that a few notes on a disease in the form of a pest of insects which has done extensive injury in many of the pine forests under my charge in the Sutlej Valley (Bashahr) may be of interest.

The pest to which my notes refer made its appearance during the summer of 1882 and spread at an alarming rate over large areas. Young vigorous trees invariably shook it off, but less hardy ones were either rapidly killed or after lingering for some time died out. The leaves of infested pines turned an unhealthy yellowish colour, and the branches dried and curled up into claws, giving a most wretched appearance. At the end of the rains the disease abated, and to all seeming disappeared, and for four years the forests were free from its ravages. But in June 1887 it returned, and this time attacked both the *Pinus excelsa* and *Pinus gerardiana*. In July I noticed that the leaves of the affected trees were beginning to change colour, and that the insect had prepared for first operations the ends of branches, and that it had tunnelled out between the bark and sapwood longitudinal galleries which, on close inspection, I found to contain larvae and weevils. I continued to observe these during the rains. . . . ; later on, when no more larvae remained, the perfect insect abandoned the tender shoots for larger branches, through which it worked holes as far as the heart-wood and in the direction of the axis of the stem. Branches thus attacked were tatooed all over and did not survive long. This destructive insect . . . . is one-tenth inch in length, with dull brown-coloured elytra, and its larva is a small white grub of the same length . . . . Its duration of activity is three months, which is as long as the rains last, for at the end of September its depredations ceased and in October I had difficulty in finding any beetles alive. But doubtless they leave behind in dead wood ample deposits of eggs, which are hatched on some favourable atmospheric change occurring.

These careful observations by G. G. M., an officer who held charge of these forests for a number of years, are of great importance, since they conclusively prove the serious nature of the damage *P. major* is capable of doing to young growth of the species it infests.

Protection and Remedies.

The measures to be taken to combat the attack of the blue-pine borer are similar to those laid down for the deodar bark-borer (*vide* p. 572). The blue-pine insect, however, only attacks poles and saplings, and will not be found to infest poles whose bark has attained a thickness which results in an outer layer or covering of old dead bark being present on the tree.

For egg-laying purposes the insect requires soft sappy bark. Consequently small poles may be felled as "trap" trees, but they must be green. The fact that they dry fairly quickly does not appear to inconvenience the insect once the larvae have become half to two-thirds grown.

In fact, in areas where this beetle exists (and my observations would seem to show that it is invariably present wherever the blue pine is present on a tract, even though the tree may be scarce), an inspection of green felled blue-pine saplings or poles or green branch-wood will almost invariably reveal the fact that they are full of this insect either egg-laying or (depending upon the time of inspection) full of larvae and pupae or maturing beetles.

From a sylvicultural point of view the most serious aspect of this beetle's work is the fact that where the blue pine is scarce on an area, and when a favourable year or succession of favourable years has led to an increase of the insect in the forest, the beetle proceeds to attack young deodar owing to the failure in the supply of the tree it prefers.

It is for this reason that the beetle fills a place of considerable importance in the deodar forest, it being the only genus of bark-borer outside the *Scolytus* at present known to infest the deodar in a serious manner.

Parasitic and Predaceous Insects.

Chalcid.—The grub is parasitic upon *Polygraphus major* in blue pine and perhaps on *Pityogenes coniferae* (p. 562).

Fly.—Highly coloured. Head, thorax, and legs purple, with a high metallic sheen ; eyes pink ; antennae nine- to ten-jointed, bent. Wings membranous, colourless, with a black elongated bar placed at about the middle of the upper one. Tibiae black, with a yellow pubescence ; tarsi yellow, last joint black. Body blackish purple, but without the high iridescence of thorax and head ; apex blunt. Length, 5.8 mm. ; wing expanse, 12 mm.

FIG. 330.—Chalcid parasitic on *Polygraphus major*. North-West Himalaya.

The fly has been identified as a species of Chalcid.

Life History.—Towards the end of June 1902 I took some specimens of this fly from their pupal chambers at the end of the larval galleries of *Polygraphus major* in blue-pine branches. The branches were badly infested with both the *Polygraphus* and also *Pityogenus coniferae*, and the insect may also be parasitic on the *Pityogenes*. I was not able to ascertain definitely this point. The fly evidently lays its eggs at the mouth of the entrance-hole made by the bark beetle in the branch, or crawls down it and deposits them in the egg-gallery. The chalcid grub probably feeds on the scolytid one as an external parasite The insect is a most useful one.

Niponius canalicollis, Lewis (p. 103).—This predaceous histerid feeds on the eggs and larvae of the *Polygraphus* and other coniferous Scolytidae. It is found throughout the coniferous forests of the Western Himalaya, and also in the *Pinus gerardiana* forests of North Zhob in Baluchistan and in the Suliman Mountain Range.

Beetle.—Elongate, narrow, cylindrical. Shining black in colour, tarsi palish ; the elytra are short, and leave exposed two segments of the body. Prothorax with a conspicuous median channel, sometimes reaching the base, but always shortened in front ; surface on either side of channel uneven, the punctures irregular in size and form. Elytra with the sutural and one humeral striae complete, the others punctiform or obsolete. The fovea on the pygidium large and circular. The tibiae slender. Length, 3½ mm. to 4½ mm.

Larva.—Elongate and flat, pink in colour, with a yellow head and twelve pink or red body-segments. Length, 12.5 mm.

The larva is to be commonly found in the larval galleries of the scolytid beetles.

Life History.—This *Niponius* is a common scolytid predator in the mountainous ranges of North-Western India. It enters the tunnels of the bark-borers through the orifices in the bark (its diameter being equal to or less than that of the insects it preys upon) and lays its eggs in the egg-gallery of the bark beetle. It is, I think, possible that it also feeds upon the eggs of the latter. The *Niponius* grubs on hatching attack and devour those of the scolytids. They are elongate and flat in shape, and are thus able to make their way between the bast and sapwood from one larval gallery to another to get at the grubs.

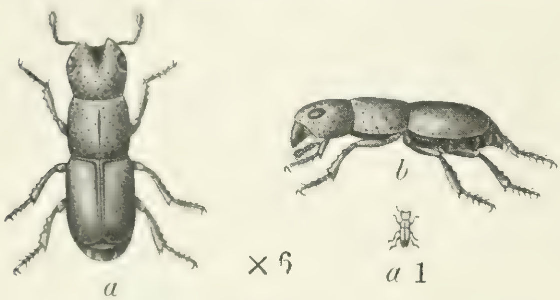


FIG. 331.—*Niponius canalicollis*, Lewis, predaceous upon *Polygraphus*, *Scolytus*, and other bark-borers. North-West Himalaya and Suliman Mountains. *a b*, enlarged; *a* 1, natural size.

The duration of the life-cycle of the insect appears to coincide with that of its hosts—from six to eight or ten weeks, and the number of generations passed through during the year varies from three to five, according to the elevation it occupies, the season, etc. A rather remarkable fact about the insect is that it is to be found attacking bark beetles infesting trees living at different altitudes in the mountains, and that it also has a wide range. It has been found in the deodar, blue pine, spruce, and *Pinus longifolia* in the Western Himalaya, and in the *Pinus gerardiana* in the Suliman Range in the far west.

The insect was first discovered in 1901 in Jaunsar, and observations made in India upon it and other bark and wood Histeridae confirm Mr. G. Lewis's opinion that numbers of the family follow bark- and wood-boring Scolytidae into their tunnels to prey upon them.

The beetle has some resemblance to the *Scolytus* beetles of the deodar (cf. pl. lvii, fig. 1, *c* 1), from which it should be distinguished. It is of great importance that forest officers should be able to recognize this valuable ally.

Thanasimus himalayensis, Stebbing (p. 186). (*The Bark-beetle Predaceous Clerid.*)—This is one of the most important and valuable of the bark-beetle predators. It is a clerid beetle closely allied to the *Clerus formicarius* of European coniferous forests. It feeds with avidity on the *Polygraphus* and many other scolytid and platypid bark- and wood-borers. I have found the insect throughout the coniferous forests of the North-Western Himalaya.

Beetle.—Head and antennae black; body short and squarish, with well-marked "shoulders." The prothorax is black and has some hairs on it. The body, which is covered by the elytra, is broader than the prothorax and head; the elytra are rounded at extremities, the basal third being red, the rest black; the black area is traversed by

two white wavy bands. The abdomen beneath the elytra and on the under-surface is bright vermilion. Length, about ½ in. Fig. *b*, *c*.

Larva.—An elongate, pink, worm-like, flat grub consisting of a head and twelve body segments. The head is brown and the mandibles are black; there is a brown patch just behind the head on the upper surface and a pair of brown spots on each of the two following segments. Each of the first three segments has a pair of legs, and the grub tapers in front. Length, ¾ in. to ⅞ in. See fig. *a*, *a* I.

Fig. 332.—*Thanasimus himalayensis*, Steb., predaceous upon scolytid bark- and wood-borers. *a*, *a*1, young larva; *b*, beetle seizing a bark-beetle; *c*, beetle devouring a *Scolytus* bark-beetle. North-West Himalaya. (E. P. S.)

Life History.—The larvae of this beetle are to be found in the tunnels of the *Polygraphus* and other scolytid grubs, where they feed upon them, moving from one gallery to another between the bark and cambium layer.

The beetles are to be seen on the wing in the forest, flying about over or running along the trunks of infested trees. Owing to their bright red bodies they are most conspicuous, and so easily visible when on the wing. They are very active, and seize with their powerful mandibles the bark-beetles they find on the trunk or just boring into the tree. Having caught a beetle the clerid holds it between its fore legs, tears off the head, and then sucks out the contents of the rest of the body. They are voracious insects, and consume a large number of beetles. The *Thanasimus* is thus of great service to the forester, and should be carefully made known to forest guards and others in order that it may not be ignorantly destroyed as a pest.

I have taken this beetle on the wing in the forest in spring, early summer, and in the autumn months (May, June, first half of July, late September, October, and early November). It is thus probable that it passes through a number of life-cycles in the year which may be identical with those of the bark-borers on which it preys. Since, however, it preys upon a number of different pests it is probable that the generations overlap, and that beetles are to be found on the wing from spring to late autumn. In favour of this theory is the fact that larvae of different sizes are usually found in any one set of bark-beetle galleries. The eggs are laid in crevices of the bark or just inside the entrance-holes of bark beetles; the grubs on hatching out crawl down the entrance-tunnel into the egg-gallery of the bark-borer, and thence reach the larval galleries. When full-fed the grubs eat out a pupating-chamber in the outer bark of the tree and pupate there.

The insect is polygamous, the males pairing with a number of females, and both continue feeding voraciously for some days.

On one occasion twenty bark- and wood-beetles (*Polygraphus*, *Scolytus*, and *Crossotarsus*) were placed in a small box with four of these clerids. On inspection three and a half hours later all the bark-beetles had been consumed, only the outer hard chitinous shells and the wings being left.

The habits and life history of this valuable ally of the forester have been dealt with fully in *Departmental Notes* (*Clerus* sp., p. 213), to which reference should be made for further details.

I am of opinion that it may prove possible to extend the range of usefulness of this insect by introducing it into areas where it does not at present exist. A few years ago Mr. Ernest Green imported the European clerid *Clerus formicarius* into Ceylon to make an attempt to cope with bark-beetles. It is probable that the Himalayan *Thanasimus*, which is larger and appears to be a hardy and aggressive species, and thus suitable for experiment, would fulfil the desired object better.

Hypophloeus flavipennis, Mots. (see p. 236).—The beetle feeds on the sap of the tree. Its grubs are predaceous or semi-predaceous on those of *Polygraphus major* and *Polygraphus pini* beetles and other bark-borers—*Tomicus*, *Pityogenes*, and *Scolytus*.

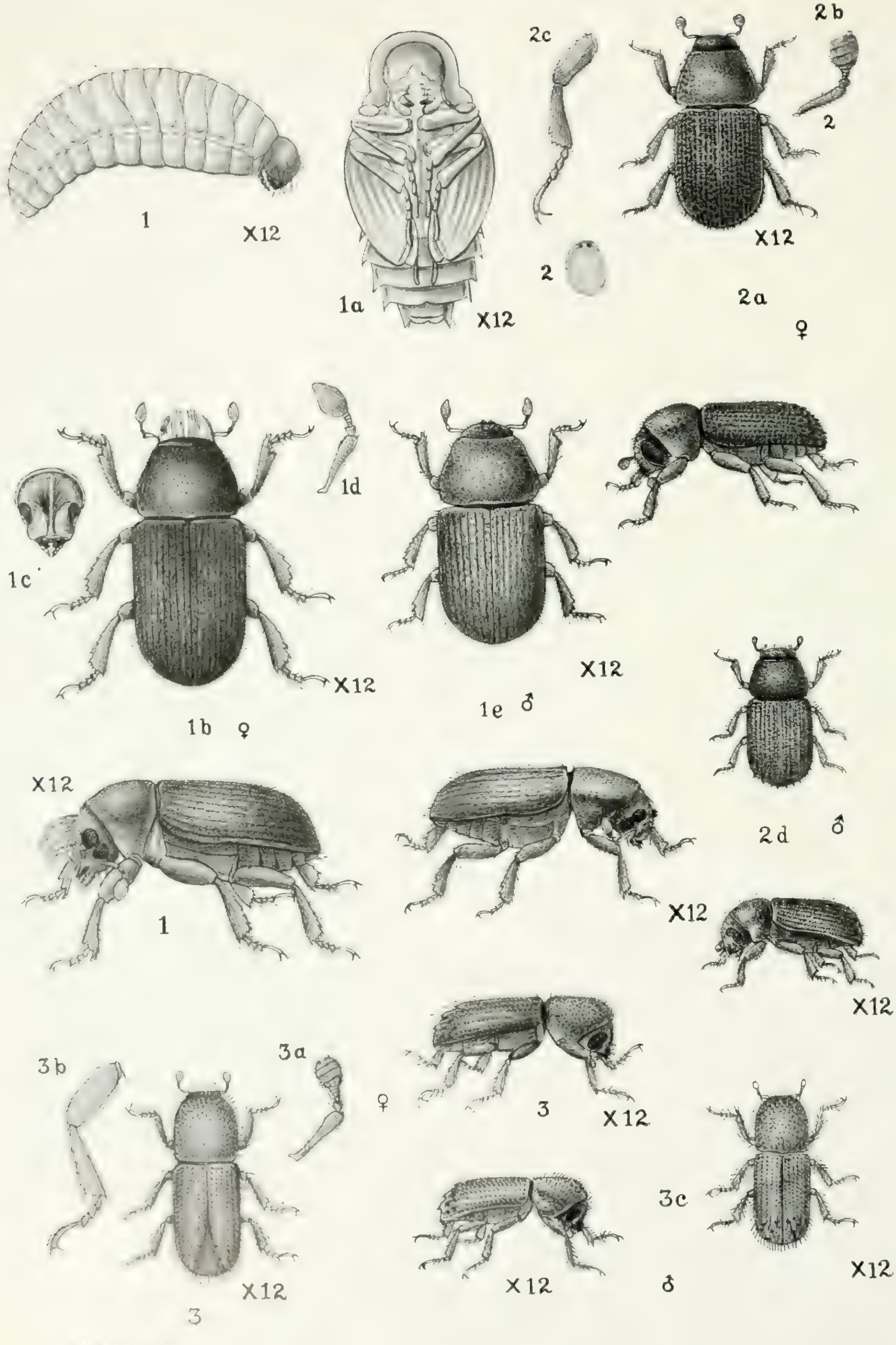
Life History.—This insect is excessively common in the North-West Himalaya, being found in abundance in the tunnels of many of the bark-borers infesting the blue pine, spruce, deodar, and chilgoza pine (*Pinus gerardiana*). I have taken the beetle itself at the beginning of May ovipositing in the egg-tunnels of *Polygraphus major*. In June I took it here and in tunnels of *Polygraphus pini* in the main stem of the tree and in spruce. In the third week of September I took a generation of the beetles on the wing, and on 15 December I again found the insect in abundance in the tunnels of *Polygraphus* and *Tomicus*, in company with *Niponius canalicollis*. The insect would thus appear to hibernate in the imago state. The beetles oviposit in the tunnels of the bark-borers, and probably feed to a certain extent on the sap oozing from the walls of their galleries. The grubs to a certain extent undoubtedly prey upon those of the bark-borers. It is not improbable that in the absence of the latter, or when they are not sufficiently plentiful, they may feed upon decaying cambium and bark materials.

Polygraphus trenchi, Stebbing.

REFERENCES.—Stebbing, *Ind. For. Mem.* Zool. Ser. i, pt. i, p. 9; id. Chilgoza Bark-bor. Beetle of Zhob, *For. Bull.* 3, p. 9 (1905).

Habitat.—Zhob, Dehra Ismail Khan (Suliman Mountains).

Tree Attacked.—Chilgoza Pine (*Pinus gerardiana*). Shinghur, Zhob (G. Chevenix-Trench), Takht-i-Suliman.



1. *[illegible] trenchi*, Steb., of the *Pinus gerardiana* in Zhob.—1, larva; 1*a*, pupa; 1*b*, female beetle; 1*c*, front of head of ♀; 1*d*, enlarged antenna; 1*e*, male beetle. 2. *Phloeosinus [illegible]*, Steb., of the *Pinus gerardiana*.—2, egg; 2*a*, female beetle; 2*b*, antenna; 2*c*, leg; 2*d*, male beetle. 3. *Pityogenes coniferae*, Steb., of the *Pinus gerardiana* in Zhob and Coniferae of the North-West Himalaya.—3, female beetle; 3*a*, antenna; 3*b*, leg; 3*c*, male beetle.

Beetle.—♀ Oblong cylindrical, black, moderately shining; two brilliant, prominent, reddish-golden brushes of hair on the front of the head; base of thorax with at times a reddish tinge; the elytra black or very dark brown with a yellowish tinge, their bases often black, the black portion often triangular in shape; the upper surface is more or less covered with small, stiff, white hairs, densest laterally. Head small, black, partially covered in front by two curved brushes of long, stiff, reddish-golden hairs (pl. xlviii, fig. 1 *c*), which take off from the anterior edge of head and occupy all the area between the inner upper edges of the eyes except a narrow channel medianly. These long brushes of hair curve towards one another medianly (the tufts on the two sides remaining apart) to about halfway down the front of the head, and then continue down it in two thin strands; a few separate hairs start from the inner surface of the eye and converge to meet the strands near their upper ends. The position and configuration of these brushes of hair serve easily to distinguish the insect. There is a brush of yellow hairs at the mouth, and the antennae are yellow and terminate in a solid club. The thorax is one-third as long as broad, and is sharply constricted at about the basal fourth, the outer angles being constricted and rounded; a median shining longitudinal line down central portion; the surface is finely pitted, but the pits are not placed closely together; the lateral margin set with a fringe of rough hairs. The elytra are finely striate, the intervals between the longitudinal striations filled with fine, close granulations which become larger and wider apart in apical fourth. Under-surface black, moderately shining, and set with small rough projections and with sparse, stiff, yellow hairs. Legs yellow, with scattered yellow hair; tibiae of front legs brownish black. Length, 3.12 mm. to 3.4 mm.

Description.

♂ Differs from female in its smaller size, in the absence of the remarkable reddish-golden brushes of hair on the front of the head, their place being taken by a few sparse yellow hairs, and in the presence of two small tubercles on the head, placed transversely. The hairs on the upper surface are also denser. Length, 2.6 mm. to 2.8 mm. Figs. 1 *b* and 1 *e* show dorsal and side views of the female and male beetles.

Egg.—The egg is small, white, round, and translucent.

Larva.—A small, curved, white maggot with a yellow head and no legs. It is shown in pl. xlviii, fig. 1.

Life History.

The life history of this insect was studied during two visits paid to the chilgoza forests of North Zhob and the Takht-i-Suliman Mountains in June and November 1905. The beetle appears on the wing in the spring, probably at the beginning of May, and lays the eggs of the first generation of the year. From a large number of infested trees examined in June, the following four are taken as showing the position of this and the second generation in the trees in the middle of June:—

Tree 1.—Mature larvae, pupae, and fully formed but immature light yellow beetles, with their outer parts still quite soft. Also one or two fully mature beetles and a few dead ones at the top of the egg-galleries in the tree.

Tree 2.—Fully mature males and females boring into a standing green tree or grooving out pairing-chambers and egg-galleries in the bast and sapwood. Eggs laid in the lower part of the egg-gallery, but no grubs yet developed.

Tree 3.—Fully grown larvae, pupae, immature and fully mature beetles. These latter were leaving the tree, and were attacking a perfectly green tree in the neighbourhood.

Tree 4.—Fully mature male and female beetles, eggs, and young larvae, the tunnels of the latter, giving off at the lower portion of the egg-gallery, being already as much as half an inch long.

The above material furnishes us with the life history of this pest from the time that it began its operations after the period of hibernation to the middle of June. The insect passes the winter as a beetle or grub; in the case of such a thin-barked tree as the chilgoza it would certainly be killed off in the pupal stage by the frost, and this probably happens to that portion of the generation which has reached the pupal stage when the winter sets in. If it hibernates as a beetle it issues from the tree as soon as the warmth of spring makes itself felt, and bores into fresh trees to lay the eggs of the first generation of the year. Should the insect pass the winter in the grub stage, the larvae will pupate with the first warmth and issue shortly afterwards as beetles. In the latter event it will be seen that the individuals who passed the winter in the mature state will have a start over those who were in the larval one, and this accounts for the apparent overlapping of generations which may be noticed in the case of this and other bark-boring beetles such as *Scolytus*, *Tomicus*, and other *Polygraphi*. By overlapping of generations I mean that in one and the same tree may be found egg-galleries with the offshoot larval galleries well advanced, and therefore a week or two old, whilst others are only just commenced by the mother beetles, they being a week or two behind the first insects to enter the tree.

In the first tree mentioned above, mature larvae, pupae, and immature beetles were found. These had all developed from eggs laid some time early in May of the year 1905. The attack commences by a male beetle boring into the tree through the bark until it reaches the sapwood. In this it eats out a depression which is the pairing-chamber. It is joined here by a female beetle who enters by the same hole. After pairing with the male the female commences to eat out a longitudinal gallery, which is always more or less parallel to the long axis of the tree. This gallery is slightly broader than the width of the beetle. On either side of it she eats out little recesses and places one egg in each. These recesses are made on both sides of the gallery, but are usually more numerous on the one side than on the other, and are closer and more evenly distributed in the lower portion than towards the apex. See fig. 308: (*a*) pairing-chamber; (*b*) egg-gallery; (*c*) recess in which egg is placed. In fact, as the egg-gallery becomes longer, the beetle's egg-laying powers appear to become weaker and more erratic. In the roof of this gallery, i.e. in the bark, she bores small circular offshoot galleries, which pierce through the bark

but do not reach quite to the outside, a plate of cortical epidermis of paper-like thickness being left to cover the hole (*d*). Two or more aeration holes of this nature are made, and they serve to admit air into the egg- and future larval-galleries. These holes are not carried right through to the outside, in order to prevent predaceous and parasitic enemies from gaining access to the inside and destroying the grubs, pupae, or beetles within. These air-holes appear to be bored in an erratic manner. At times the egg-gallery will contain three or more right at its commencement, and their number and position doubtless depend to a great extent on the healthiness of the tree and the amount of resin it is capable of exuding at the spots attacked. If this is in such quantities that the entrance-hole of the male and female beetles becomes blocked, the females doubtless have to add considerably to the number of the air-holes in their egg-galleries. This may also in part be responsible for the number of female beetles who enter and pair with a male. The number is evidently very variable, at any rate in the case of the spring and early summer generations. There are always two, but there may be as many as four. The second female beetle entering by the entrance-hole, after pairing with the male, carries her egg-gallery in the opposite direction to that of the first. If the latter has gone up the tree she will go down, and vice versa. These egg-galleries, at any rate in their lower halves, are always packed with the wood-dust eaten out by the beetle as she carries the tunnel onward, and this probably prevents a second female from commencing her gallery in the same spot. If a third beetle pairs with the male she carries her gallery either up or down the trunk, parallel to, but not in connection with, that of the female which has previously taken this direction. If there are four females, two egg-galleries will be found proceeding up the tree and two down, each taking off from the pairing-chamber. I have never found more than four females with one male. At times as many as three beetles will be found in the pairing-chamber, perhaps a short egg-gallery having been started at one or both ends. In this case it is possible that the female beetles help the male to enlarge the pairing-chamber. The galleries vary in length from $1\frac{3}{4}$ in. to $2\frac{3}{4}$ in., the number of eggs laid in each being from fourteen to eighteen. Probably about a week to ten days is spent in making the egg-gallery, and the lower eggs hatch out into grubs before the beetle has finished boring the gallery and ovipositing (fig. 308, *c*). Only a day or two is spent in the egg stage. The grubs on hatching tunnel away from the egg-gallery in a direction which is more or less at right angles to it in the case of those first hatching, and therefore the lowest eggs, the direction, however, trending upwards (or downwards when the egg-gallery is carried downwards) in the case of the eggs laid higher up the gallery. In this manner a pattern which has a constant definite plan is made. The larval galleries are short, not being more than $1\frac{1}{4}$ in. to $1\frac{1}{2}$ in. in length, and they groove both bark and sapwood. When full-grown the larva eats out in the sapwood an oval-shaped depression, and

changes into a pupa within this. Fig. 333 and pl. xlix show pieces of bark completely covered with the pairing-chambers, egg-galleries, larval galleries, and pupating-chambers. The pupa turns gradually into the immature beetle, and the latter remains for a time resting in the chamber whilst its outer parts are slowly hardening and it is becoming darker in colour.

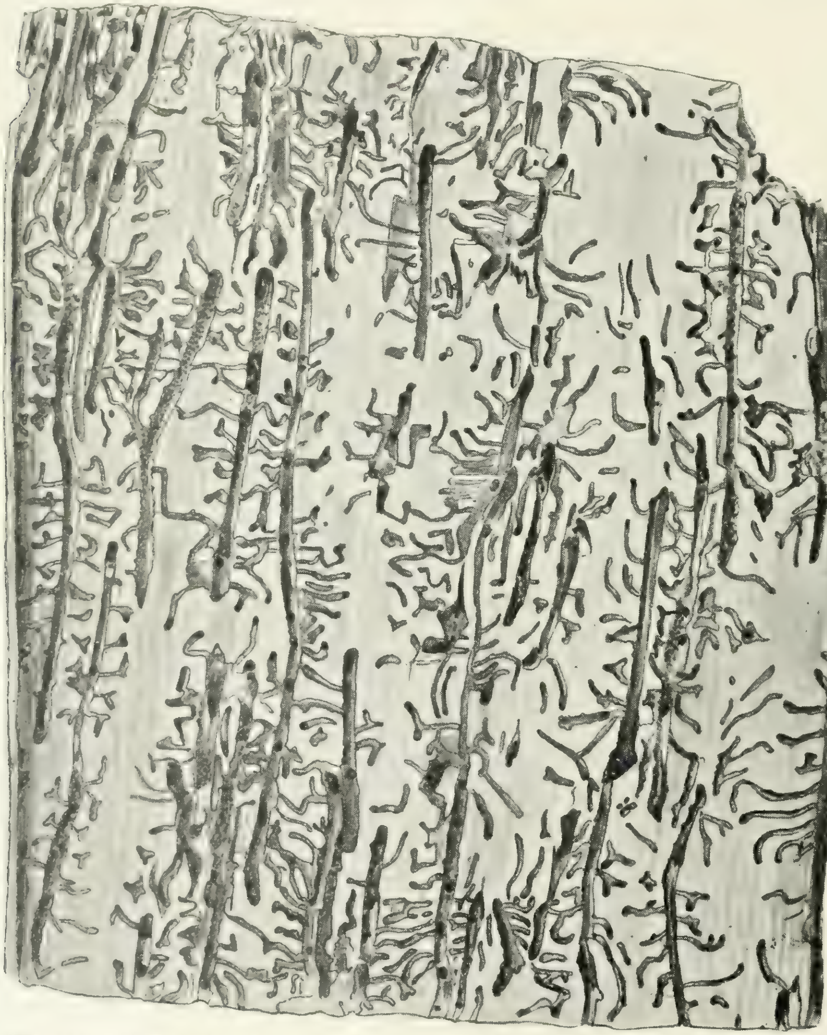


FIG. 333.—Egg and larval galleries of *Polygraphus trenchi*, Steb., on inner bark of *Pinus gerardiana*. North Zhob, 1905.

When fully mature, the beetle bores straight out of the bark by a tunnel eaten out horizontally from the spot where it is lying. In the case of the spring generation, when the weather is still comparatively cold, as much as five weeks are probably spent in the larval stage and a

fortnight in the pupal and immature beetle stages, the generation taking about two months to complete from egg to perfect insect. It will be understood from the above that numbers of the beetles will mature and leave the tree together, and this is what actually happens, and explains the state of affairs seen in the second and fourth trees alluded to above. In the first and third the insects maturing were those from the first set of eggs laid in the spring of 1905. In the second and fourth we find beetles all more or less in the same stage, i.e. the egg-laying one (especially in the case of the second tree), the reason being explained by the fact that they had left the tree in which they had been bred, and flown in a swarm to the one in which they were found.

Further investigations were made into the life history in November of the same year, and reports were submitted to me on the subject in following years. It has been mentioned that the insect passes through three, and often four, life-cycles in the year, and it has been shown that eggs, the eggs of a second generation, were being laid in the trees in the latter part of June, and that some of these had already developed into grubs. Beetles from this generation issue from the trees about the end of July, and lay the eggs of a third generation in fresh trees at the commencement of August. This generation matures towards the latter part of September, issues from the trees, and lays the eggs of a fourth generation in other trees. The progress in the development of this latter generation will depend entirely on the weather. In the case of the earliest-laid eggs, i.e. those laid by the descendants of the beetles who got the first start in the spring, the larvae hatching from them proceed as far as the beetle stage and pass through the winter as beetles, whilst those of the later ones may winter as grubs. This I found actually to be the case in November 1905, as I took both beetles and grubs in the trees. In any case a certain number may have proceeded as far as the pupal stage when the first cold snap catches them, and will probably be killed during the winter.

Damage Committed in the Forest.

The relation of this bark-borer and of its companion *Phloeosinus zhobi* (p. 496) to the chilgoza forests of Zhob and the Suliman Range generally is of very considerable interest. The preservation of these forests in this region has a two-fold importance:

(1) *To preserve and increase the water supply.*—It is a fact which it would be difficult to gainsay that the springs which exist on the Shinghur Range, and which give water to the valleys on either side, are practically entirely dependent upon the hills remaining covered with the chilgoza tree. Poor as is this covering in parts, it is assisted by an undergrowth of such plants as ephreda, berberis, ash, cotoneaster, spiraea, wild almonds, dog-rose, etc. It is improbable that any of these would be found upon the area in the absence of the chilgoza forest.

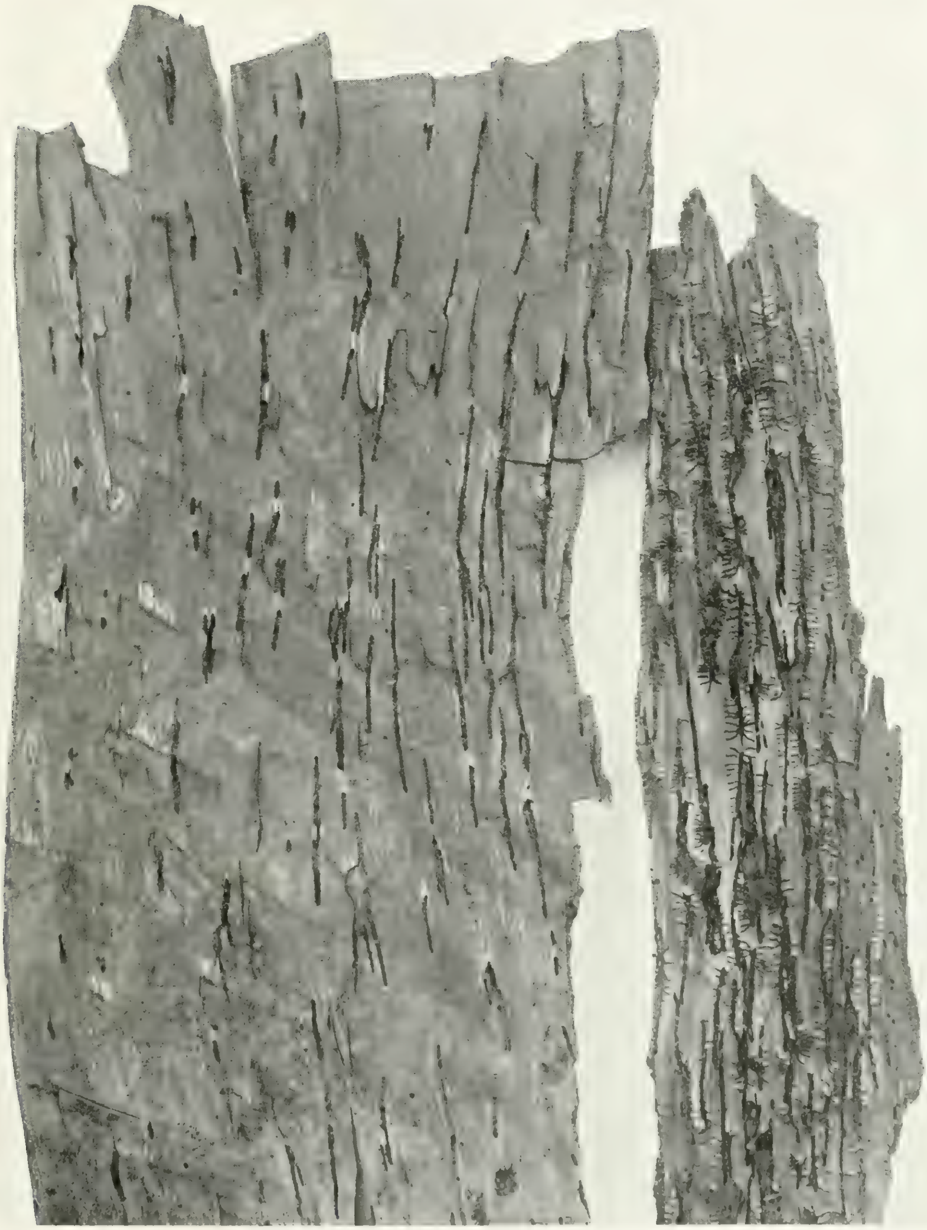
(b) *To maintain the supply of edible seed for the surrounding population.*—On account of the edible qualities of its seed the chilgoza is a most valuable tree, and this fact would not seem to have been fully realized in the existing reports on these forests. The question of the timber is alluded to, and the demand or want of demand for the latter article is discussed. This demand should not seriously affect the question, for only dead wood will be removed. The value of the forest is due to the edible nature of the seed, and is obviously enhanced by the fact that no trees, or very few, need be inaccessible so far as the collection of their seed is concerned. Were this collection done in a thorough and systematic manner, it would be found that the value of the forest in this respect would be thirty to forty per cent. greater to the village communities than it is at present, whilst at the same time seed would be available for regeneration purposes.

From the life history detailed above, it will be obvious that the bark-borer is able to kill off the trees once it has got a firm hold of them, and when favoured by a succession of dry, hot seasons. The feature of the attack of 1900–1905 was the high proportion of trees affected, and the even higher percentage of infested trees which succumbed to the beetle. The investigations carried out in November 1905 definitely proved the fact that the insect passes through at least three generations in the year and a partial fourth. But for the operations introduced by Colonel G. Chevenix-Trench, C.I.E., to combat the insect, it is certain that an even higher proportion of trees would have been lost. These operations, accompanied by a greater rainfall in the years 1907 and 1909, enabled the attack to be completely stamped out in the Shinghur Forest. The point to be insisted on in the case of this insect, therefore, is its power of killing the trees if left unchecked, and the possibility of stamping out an attack if the beginnings of it are recognized in time, and methods to combat it are introduced at once.

In his report on the Shinghur Forest, written after a visit in the winter of 1892, Mr. Elliot wrote: "Many trees are dead, the cause in some cases being fire, in others probably the severe conditions of life, considerable heat in summer, great cold in winter, high winds at all times, and scanty rainfall." Mr. Downe in a note on a visit paid in 1900 quoted this statement. It cannot, however, be borne out by the true facts of the case, which were indelibly inscribed on the trees themselves in 1905.

The most serious point about this bark-boring-beetle attack is the fact that the chief pest will infest indiscriminately both healthy and sickly trees. The Scolytidae usually confine themselves to the latter, only attacking the former when driven to do so by a shortness in the supply of trees reduced in vitality. The chilgoza *Polygraphus* is a marked exception, and as such must be considered as forming a most serious menace to the forest, and not only to the forest at Shinghur, but to the neighbouring ones at Sherghali, the Takht, and Spiraghar.

I think this *Polygraphus* also infests the *P. gerardiana* in Bashahr.



Inner surface of pieces of *Pinus gerardiana* bark showing the egg and larval galleries of *Polygraphus trenchi*, Steb. In the larger piece uncompleted egg-galleries are shown with only the first beginnings of the horizontal larval galleries. North Zhob, Baluchistan, June 1905.

Protection and Remedial Measures. Owing to the more or less isolated nature of the chilgoza forests in Zhob, it should prove quite possible to stamp out incipient attacks of this beetle and its companion the *Phloeosinus* as soon as they appear, and to prevent their spreading to adjacent areas. The severe attack experienced in the Shinghur Forest and neighbouring areas took place in what was a virgin forest untended till then by man. The destructive method of collecting the cones from the tree by breaking off the branches to get at them, combined with a succession of hot dry years, doubtless led to the great increase in the number of beetles present in the forest. At Shinghur the trees do not stand densely on the area, and the open nature of the forest is probably due to a number of them having been killed out by the beetles. A possible reason for this state of affairs is to be found in the fact that the chilgoza seed has been collected with more regularity since the British have been in the country, and that this more intense collection has resulted in a greater number of men frequenting the forest, and in a greater amount of damage being done to the trees in consequence, thus providing the beetles with a larger supply of easily-got-at food material. Grazing and its concomitant damage has also certainly been more intense than was the case when the forest first began to occupy the area. In considering measures for endeavouring to stamp out the pests, or for reducing their numbers to a point at which they will no longer be harmful, it will therefore be needful to remember that the forest must be treated as a whole, and the entire area carefully taken in hand and worked over.

We have seen that the signs of attack are easily observable on the outside of the trees in round shot-holes usually surrounded by a ring of resin to which wood-dust may be sticking, and in pear-shaped blobs of turpentine or long trickles of this substance being present beneath the shot-holes (cf. pl. xli).

The methods of dealing with such attacks are detailed in chap. iv, p. 46.

It should be most carefully borne in mind that the very greatest circumspection must be used in—

(*a*) Selecting the trees for felling.

(*b*) Felling them at the right time.

The reasons for (*a*) are obvious, since the tree is valuable on account of its seed and not for its timber, and therefore produces an annual income which ceases when the tree is felled. It is essential that the infested trees should be removed; because, beyond the fact that they themselves will die under the beetle's attack, other trees will become subsequently infested from the insects they breed, and will be killed in their turn. (*b*) The felling at the right moment is necessary, because otherwise the benefits to be obtained (i.e. the large number of insects destroyed, and the consequent diminution in the number available to do further damage in the forest) will be lost. Whilst, therefore, a careless selection of the trees to be

felled will result in an unnecessary loss in the annual income from the forest, the omission to remove trees seriously infested by the beetles will result in greatly lessening the value of the fellings made, and will necessitate further removals of trees in the year or years following.

The practical effect of the remedies recommended was illustrated in the severe attack of these bark beetles which took place in the Shinghur Forest in Zhob in 1900–1906. Work was begun in the autumn of 1905, and carried on throughout 1906, the Political Officer, Lieut.-Colonel G. Chevenix-Trench, being ably assisted by the Forest Officer, Bhai Sadhu Singh; and the fellings undertaken, combined with the burning of all infested trees felled, practically stamped out the attack.

My examination of the infested trees in the Takht-i-Suliman area in November 1905 proved that the beetles passed through four generations in the year. From rough calculations made from measurements taken on the ground, it was computed that an average-sized tree in the Shinghur Forest could produce at a rough estimate a generation of 40,000 beetles. Allowing for 50 per cent. casualties, this would give rise by the end of the year to a progeny of 40,000,000 beetles, on the supposition that the insect passed through four generations only during this period.

From this calculation it follows that the removal of the 92 badly infested trees, and the burning of the bark containing immature larvae, pupae, and beetles, may be safely estimated to have reduced the beetles that would have been present in the forest in the spring of 1907 by some 500,000,000, allowing for very heavy mortality amongst the over-wintering larvae and pupae.

Parasitic and Predaceous Insect Foes.

The *Polygraphus* and *Phloeosinus* beetles are subject to the attacks of predaceous and parasitic insect foes, and it may be due to this fact that the bark-borers have not been able to increase in such numbers as entirely to destroy such a local area of trees as the Shinghur Forest represents. Trees Nos. 3 and 4 were swarming with these active predaceous foes, the insects being found within tree No. 3 and on the bark, and entering tree No. 4. No less than six different kinds were collected, all actively engaged in feeding upon or ovipositing in the galleries of their hosts. It is probable, I think, that one or more of these insect enemies are predaceous upon or parasitic in one or more of the insects predaceous upon the bark-borers. They include two hymenopterous flies, an undescribed species of *Niponius*, two species of Colydiidae, and a species of predaceous bug, the *Niponius* being perhaps the least abundant of the six.

The Hymenopterous Flies.—These flies are probably species of the family Chalcididae. They lay their eggs either in or amongst the eggs of the bark-borers, or in or on the grubs. They were to be found numerously in the trees, and their grubs evidently do not kill the grubs of

their hosts until they have become full-fed and eaten out the pupal chamber, since the pupae of the flies were often found in the latter.

They are deep metallic blue in colour, with green reflexions, the head and the thorax being dull coppery. The eyes are brilliant crimson. In the larger of the flies the wings have a transverse brown band across them about half-way up. The figures show these two flies.

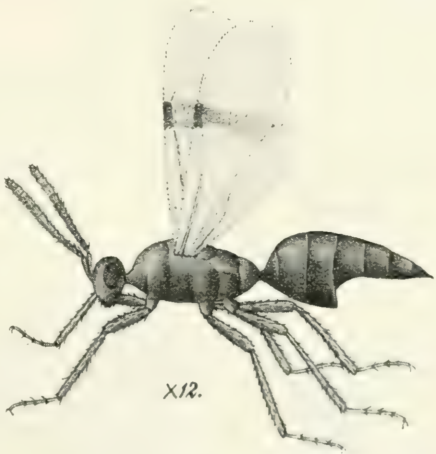


FIG. 334.
Flies parasitic on *P. trenchi*.
North Zhob.

Niponius canalicollis, Lewis.—The grub of this beetle is predaceous upon the grubs of the *Polygraphus* and the *Phloeosinus* beetles. The insect has been already described on p. 507.

The Colydiid Beetles.—The larger of these is predaceous upon the *Polygraphus* beetle. In the galleries of the *Polygraphus* I discovered numerous smallish white eggs laid several together, and simply deposited on the floor of the gallery. From their position, and the fact that male and female colydiid beetles were taken together in the *Polygraphus* galleries, I consider that these eggs are those of the larger of the colydiid beetles, and are laid in this position to enable the larvae on hatching out to feed upon the eggs or larvae of the *Polygraphus* beetles. I took a male and female of this insect together in one of the egg-tunnels of the *Polygraphus* beetle.

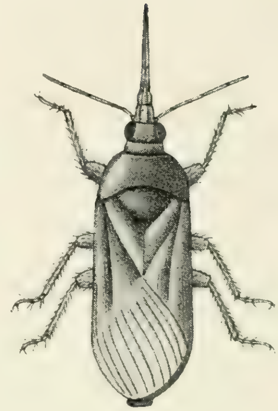
FIG. 335.
Beetle predaceous upon *P. trenchi*. North Zhob.

The smaller of the colydiid beetles may confine itself to the *Phloeosinus* bark-borer, or may be predaceous upon one of the enemies of the bark-borers.

Beetle.—Light brown in colour, with a prominent head furnished with large black eyes and short antennae; the thorax is square and pitted, as also are the elytra, which leave the tip of the body exposed. Fig. 335 shows the larger of the two colydiid beetles.

The Black Bug (*Hemiptera*).—The last of the predaceous insects taken is a small, elongate, narrow, flat, shining, black bug, furnished with a strong, four-jointed, elongate, black proboscis, the last segment being pointed and yellowish. This projects from the top of the head, which is small. The wings are membranous and palish yellow, the upper being folded across the lower. The thighs of the legs are thickened and black, the rest of the legs being yellowish. Length, one-eighth inch, excluding the beak (*vide* fig. 336).

This little bug was very plentiful in the trees, and is most probably, I think, predaceous upon the *Polygraphus* grubs, pupae, and perhaps beetles.



x12.
FIG. 336.
Bug predaceous upon *P. trenchi*. North Zhob.

Polygraphus nigra, Stebbing.

(*The Black Polygraphus.*)

REFERENCE.—Stebbing, *Depart. Notes* (*Hylesinus?* sp.) i, 258.

Habitat.—North-West Himalaya.

Tree Attacked.—Blue Pine (*Pinus excelsa*). Jaunsar.

FIG. 337.

Polygraphus nigra, Steb. *a*, beetle; *b*, egg-galleries in blue-pine bark. North-West Himalaya.

Description.

Beetle.—Cylindrical, black, moderately shining, head and thorax punctate, elytra striate and pitted. Head short, vertical; finely rugose behind, with a few punctures anteriorly, pubescence yellow, stiff; antennae brown. Prothorax slightly convex, half as wide again at base as anteriorly; punctate, the punctures large, deep, numerous; a median longitudinal smooth line not reaching to anterior margin. Elytra rounded at their posterior declivity; nearly twice as long as prothorax, longer than wide, slightly dilated at apex, moderately dull, with close scales; striae faint; pubescence short, whitish yellow. Legs fairly stout, with largish tibiae; dark ferruginous. Tarsus yellowish brown. Length, 3.2 mm. Fig. 337, *a*, shows a dorsal and a side view of this insect.

Larva.—Pinkish yellow in colour, broadest anteriorly, corrugated and curved. When first hatched, yellow.

This beetle was first discovered in the blue pine in June 1902.

Life History.

It bores into the boles of large trees, coming in much later than the blue-pine *Tomicus*. The beetles were found boring egg-galleries in the bark in the third week of June, when the adults of the first generation of the blue-pine *Tomicus*, which were plentiful in the tree, were nearly mature, some having already left the bark. It is thus evident that it requires bark less fresh than does the *Tomicus*. In thus attacking the tree at this stage, and in its habit of infesting old trees, it differs from *Polygraphus major*, which it resembles in size though not in colour or habits. The insects found in June were probably those of the first generation of the year engaged in laying the eggs of the second generation. The difference in the life history between this and the larger *Polygraphus* may be summed up as follows :—

P. major was at the time only just maturing as a beetle (first generation) in the branches of the blue pine. It was numerous in the tree from which *Polygraphus nigra* was obtained.

P. major does not attack the main trunk of the tree; it attacks the tree in a fresher condition, requiring fresh sappy cambium for its grubs. The egg-galleries of *Polygraphus nigra* differ entirely in character from those of the large *Polygraphus*.

Towards the beginning of November 1906 I again took this insect, and made a more detailed study of its method of attack in the blue pine. These observations modify and supplement some of those given in *Departmental Notes*.

Beetles were taken ovipositing in a section of the butt of a large felled blue pine. The section girthed about twelve feet. I was able to confirm my previous observation that the beetle does not enter the tree until it has lost its first freshness, coming in as the generation of *Tomicus ribbentropi* is leaving the tree. In the case observed in November, the beetles were either just tunnelling into the tree and eating out the egg-galleries in the bast and sapwood, or their egg-galleries were complete and the larvae already about half-grown. The male beetle, which is smaller than the female, bores in through the bark and eats out a large pairing-chamber of irregular shape about a third by a quarter of an inch. From three to six females enter the pairing-chamber and are fertilized by the male. The first female appears usually to eat out her egg-chamber in a direction parallel to the long axis of the tree; the others may go in the same direction upwards or downwards or at right angles to the direction of the first. The eggs, as usual, are placed in small notches at the sides of the egg-gallery, the larval galleries taking off on both sides of the egg-gallery, and at right angles to it, as shown in the figure. Only in exceptional cases apparently do the larval galleries develop on one side only of the egg-gallery. The pairing-chamber and egg-galleries groove both the bast and sapwood, the latter but slightly. The egg-galleries are almost free of wood-dust, small masses only occurring here and there in them. The larval galleries are eaten out in the bast only. They average from five to six

inches in length and are tightly packed with wood-dust and excreta, orange-yellow in colour. The beetles themselves are very sluggish in their movements, being by no means so active as *P. major*. The beetle passes through at least three generations in the year.

Relations to the Forest.

Further observations are required to be carried out on this insect. I have taken it on only a few occasions, and, so far as my present observations seem to show, it is not abundant. This point, however, I put forward with diffidence, as the insect seems to have so strong a vitality, and its attacks to be of such a serious nature so far as the amount of bast ruined by the egg and larval galleries resulting from one swarm of beetles is concerned, that it is important that a further study of its habits should be made.

Polygraphus himalayensis, Stebbing.

REFERENCE.—Stebbing, *Ind. For. Mem.* Zool. Ser. i, pt. i, 8.

Habitat.—North-West Himalaya.

Tree Attacked.—Chir Pine (*Pinus longifolia*). Jaunsar.

Description.

Beetle.—Slightly narrower than *P. major;* sides of prothorax less angular, shining black, with a very scattered sparse pubescence. Head finely punctate, with the frontal brush of hair short and almost obsolete. Prothorax one and a half times as broad as long, smooth medianly, with no median longitudinal carina, sides with a sparse fine punctation ; the transverse channel in the anterior fourth deeper and closer to anterior margin than in *major*. Elytra very rugose, striae absent in basal half ; sutural stria most prominent in apical half where the rugosities are more open than in basal portion ; pubescence almost absent basally, very sparse in apical half. Length, 3.3 mm.

I know little about this insect. The specimen from which the beetle is described was taken in a pine tree at Jeromula in Jaunsar. From old galleries examined, the insect was noted to oviposit in the bast of the main bole of old trees. The insect was taken in the bast layer in the middle of October 1906.

Polygraphus pini, Stebbing.

REFERENCES.—Stebbing, *Polyg. minor, Ind. For. Mem.* Zool. Ser. i, pt. i, 8 (1908) ; id. *Depart. Notes*, i, 239 (1903). [I find that the specific name *minor* is preoccupied by *P. subopacus*, Thomson, var. *minor*, Lindemann (1875.)]

Habitat.—North-West Himalaya.

Trees Attacked.—Blue Pine (*Pinus excelsa*) ; Spruce (*Picea morinda*). Jaunsar, Simla, Chamba.

Description.

Beetle.—Oblong, sub-cylindrical. Black, shining, elytra with a greyish pubescence. Antennae yellow-brown, club bright yellow. Legs chestnut-brown, tarsi yellow. Smaller than *major*. Upper part of front of head furnished with a central thick close circular brush of reddish-yellow hair pointing inwards. Prothorax depressed anteriorly, the transverse channel in anterior fourth broader, deeper, and markedly prominent both medianly and laterally, the disk more strongly convex in posterior three-fourths than in *major;* punctures finer and more regularly distributed on surface. Elytra shining black, twice as long as prothorax, slightly dilated at apex, striate-rugose, the striae faint in the basal half, which is coarsely rugose. Abdominal segments black, shining, punctate, with a sparse pubescence scattered uniformly over them and not confined to the posterior margins as in *major*. Length, 2.1 mm. to 2.75 mm. Pl. xlvi, fig. 2, shows this beetle.

Larva.—Resembles that of *P. major*, but is smaller in size.

Life History.

The beetles of the first generation of the year issue early in May, and tunnel into trees to oviposit. The beetle is usually or often found in company with *Tomicus ribbentropi* (p. 552) in the trees. It appears to come in a little later than the larger beetle, and it is possible that it seeks out trees already attacked by it. The insect remains in the trees longer than the *Tomicus*, and will attack trees whose bark has lost the freshness the latter requires. It thus resembles in habits *Polygraphus nigra*, though it differs in appearance, size, and abundance from that insect. *P. pini* infests the bole of the tree and is only rarely found in the tops and branches in company with *Polygraphus major*.

It is probable that this insect has three to four generations in the year in favourable seasons, the first flight of beetles, from the eggs laid at the beginning of May or late in April, appearing towards the end of May (I have found pupae and lightish-brown immature beetles in the galleries on 22 May). These at once lay eggs, and a second generation of beetles appears about the beginning of July. Immature beetles were found on 22 June at about the same elevation as those found on 22 May. A third brood of beetles from eggs laid by these latter makes its appearance at the end of September and beginning of October, and at once lays eggs. These latter develop into larvae, some of which may reach the beetle stage and thus pass through the winter. It would appear, however, that a large number pass the cold weather as larvae enveloped in a thin, white, papery cocoon at the end of their larval galleries, which they slightly enlarge. In April these probably turn into pupae, the resulting beetles emerging from the tree towards the end of the month or some time early in May.

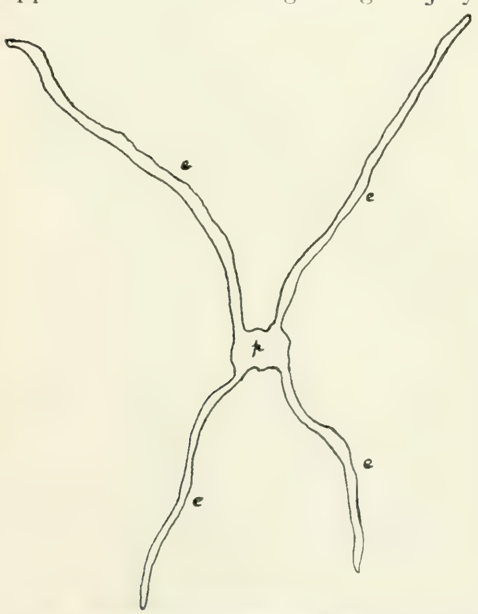


FIG. 338.—Pairing-chamber *p* and egg-galleries (*e*) of *Polygraphus pini*, Steb., in blue pine. North-West Himalaya. (E. P. S.)

The number of generations in a year and the time spent in each life-cycle require further study and corroboration, as there is not improbably a certain amount of overlapping.

The ♂ bores into the bast through the bark of the tree and excavates in it a pairing-chamber, being joined there by the ♀. At present my observations have shown me that there are always two beetles to be found in this chamber whilst it is under construction. After pairing has taken place the ♀ bores an egg-gallery away from the chamber in the bast and lays her

eggs in this. The number of egg-galleries bored away from the pairing-chamber appears to be three or four (fig. 338). It often happens that in leaving the pairing-chamber the ♀ bores the egg-gallery for some distance in the thick bast-layer without breaking through the inner surface. In such cases the number of egg-galleries bored away from the pairing-chamber appear to be smaller than they really are. The larval galleries are situated entirely in the bast, and take off approximately at right angles, but curve away later on (see pl. li). The sapwood is not touched either by the egg or larval galleries. The egg and larval galleries are closely packed with wood-dust and ejected particles.

Relations to the Forest.

This *Polygraphus* confines itself almost entirely to the bast and bark of the tree, making no, or very little, impression on the sapwood. Its galleries run in the bast nearer to the outside of the tree than those of the *Tomicus*, which groove deep into the sapwood. Like the latter, however, it appears to prefer the thick bark and bast layer of the main trunk of the older trees. It is always in greater numbers here, though it is to be found more rarely in the softer portions affected by the larger species of the genus (*P. major*). It has also been found in company with *Polygraphus nigra*. Its presence can be detected by the small shot-holes appearing on the outside of the bark, these latter being much smaller than those of the *Tomicus*. It also attacks the spruce in a similar manner to the blue pine in company with the blue-pine *Tomicus*. Remedial measures are the same as those given for this latter insect (p. 555).

Polygraphus longifolia, Stebbing.

(*The Long-needled Pine Polygraphus.*)

REFERENCES.—Stebbing, *Ind. For. Mem.* Zool. Ser. i, pt. i, 10; id. *Depart. Notes*, i, 255.

Habitat.—North-West Himalaya.

Tree Attacked.—Chir Pine (*Pinus longifolia*). Jaunsar, Tehri Garhwal, Kumaun, Bashahr, and Chamba.

Description.

Beetle.—Oblong. Head black, prothorax and elytra dark chestnut-brown. Antennae and legs yellow, the legs, except tarsi, with a slightly chestnut tinge. Head with the circular brush of hair on front, sparse, short; vertex almost smooth, with a very fine shining short median longitudinal line posteriorly meeting prothorax (sometimes absent); a few fine very scattered punctures. Prothorax about a fourth as broad as long, with the transverse channel in anterior fourth very much less prominent than in *pini* and scarcely reaching down on to sides; punctate, the punctures not dense. Elytra not quite twice as long as prothorax, slightly dilated towards apex; striate-rugose, the rugosities disappearing in the apical fourth; most prominent basally, where the elytra are clothed with a fine whitish-yellow pubescence interspersed with a few long stiff yellow hairs, the rest with a fine sparse pubescence; the sutural stria most prominent medianly. Length, 2.75 mm. to 3 mm. The male is smaller than the female. Pl. li, fig. 1*b*, 1*c*.

Larva.—White, curved, and corrugated. Head small, yellow, shining. Length, 2.75 mm. Fig. 1.

Pupa.—White tinged with yellow, constricted posteriorly with small flaps, the wing outgrowths on the dorsal surface, and short legs and antennae on lower surface. Fig. 1*a*.

Egg and larval galleries of *Polygraphus-pini*, Steb., on the inner surface of bark of the blue pine (*Pinus excelsa*). Jaunsar, North-West Himalaya.

Life History.

A generation of this beetle appears on the wing about the beginning of June from eggs laid some time during April by the generation of the insect which passed through the winter in the tree.

This beetle is a common pest of the pine in Kumaun and the areas to the west, Jaunsar and Tehri Garhwal. The male beetle bores through the thick bark of the tree, making a circular entrance-hole which is usually very distinctly seen on the outside (cf. fig. 1*d*, which shows several entrance-holes and one in section). This entrance-tunnel leads to an enlarged circular or heart-shaped chamber, the pairing-chamber, which is eaten out either in the bark itself or (where the bark is thinner) in the bast and sapwood. It will not infrequently be found, however, that there is no evidence of this chamber in the sapwood.

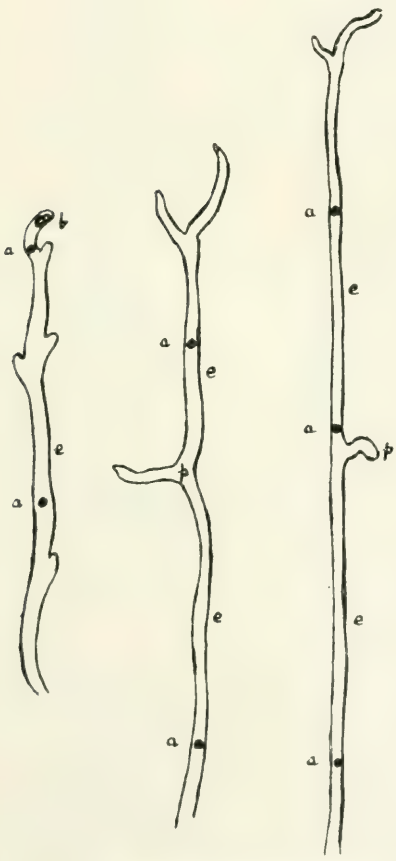


FIG. 339.—Pairing-chambers and egg-tunnels (containing living beetles) of *Polygraphus longifolia*, Steb., in the inner surface of *Pinus longifolia* bark just stripped off the trees. *p*, pairing-chamber; *e*, egg-gallery; *a*, aeration-hole; *b*, a beetle eating out a gallery. Jaunsar, North-West Himalaya. E.P.S.

From two to three (or at times four) female beetles enter successively the pairing-chamber and after fertilization eat out each a long gallery in the bast layer of the tree; these are the egg-galleries, and they are carried in opposite directions, or two up and one down (if three females pair with a male), parallel to the long axis of the tree (*g* in fig. 1*e* indicates the egg-galleries; the egg-gallery is either quite straight or it may have small zigzag curves in it or even small off-set prolongations (*vide* fig. 339), and may be as much as three inches in length. Two or more holes are eaten out by the female beetle through the bark to the outside to allow of air entering the gallery, which is otherwise blocked up its whole length with the loosely packed wood-dust and excreta of the beetle, much in the same way as is the tunnel of *P. trenchi*.

The eggs are placed, as is customary with these beetles, in small notches eaten out in the walls of the egg-gallery. The larvae on hatching out make very irregular galleries carried in a direction more or less at right angles to the egg-gallery. The galleries are made entirely in the bast layer, and the

larvae pupate here as well, except in the case where small branches are infested, when the pupating-chamber is eaten out in the sapwood to some extent. The beetle lays as many as sixty to seventy eggs, half being laid on each side of the tunnel (fig. 1*e*). The larvae from the eggs laid on the outer side of the tunnel appear to do best.

The insect passes through three to four life-cycles in the year. The first eggs of the year would appear to be laid in the trees during April, the first generation of beetles issuing towards the beginning of June. The eggs laid by these beetles produce a second generation some time in August, which is followed by a third about the middle of October, which lays the eggs which hatch out into the larvae to be found in the trees in November. These larvae either mature into beetles which hibernate in the trees, or they themselves pass the winter in their tunnels. It is quite possible that in favourable years there may be a complete fourth and partial fifth generation of the insect in the year.

The beetle is a common pest of the pine in Kumaun and in areas to the west—Jaunsar, Tehri Garhwal, Chamba, and Bashahr.

Damage Committed in the Forest.

This *Polygraphus* must be classed as one of the more formidable of the scolytid pests of the chir pine, since it will infest trees of all ages from the small seedling and sapling to the oldest tree, and it attacks green trees. I have taken it in small saplings newly killed in the Buldhoti Plantation in Kumaun, and in a large standing green tree near Kathian in Jaunsar. In freshly blown down and newly felled trees in Bashahr and Chamba I have taken the insect in large numbers occasionally, having found it infesting the tree from crown to base of stem. It often accompanies the large *Tomicus* pest, *T. longifolia* (described later on), in its attacks on the tree.

I felled two newly dead trees in the Buldhoti Plantation on 7 June 1908. The one, a sapling of 8 in. girth, had the yellow needles still on the branches. An examination showed that the tree had been attacked from crown to base of trunk by this beetle, the egg and larval galleries covering nearly all the branches and main stem (fig. 1*e*). The attack had probably commenced in the previous October and been continued by the April (1908) beetles laying the eggs of the first generation of the year. The second tree, one of 2 ft. 6 in. girth, was a green standing tree showing evidences of being in a very sickly state, there being considerable masses of resin exuding in "tears" down the bark. An examination showed it to be severely infested by the *Cryptorhynchus brandisi* weevil, the *Nothorrhina muricata* longicorn, and this *Polygraphus* beetle. *P. longifolia* was not in so advanced a stage here as it was in the sapling; larvae, pupae, and immature beetles being present in this tree. I have already alluded to the fact that I took the beetle fairly numerously from the base of a large green tree of 14 ft. girth, standing closely adjacent to the Range Office at Kathian in Jaunsar. This tree was situated at about the upper limit of this pine in Jaunsar.

Polygraphus longifolia, Steb., in *Pinus longifolia*.—1, 1*a*, larva and pupa; 1*b*, 1*c*, male and female beetles; 1*d*, entrance-holes of beetles in outer bark of the tree; 1*e*, pairing-chamber (*p*), egg galleries (*g*), larval galleries (*l*), and aeration holes (*a*) in the bast layer. North-West Himalaya.

Owing to the rough thick bark of the *Pinus longifolia* and the deep crevices in it, it is by no means easy to detect the attacks of this insect without removing the bark. Often, however, the red and white wood-dust ejected by the male when tunnelling down into the tree to prepare the pairing-chamber, which either projects in a tiny cylinder from the surface of the bark or forms a little powdery mass just below it, attracts the attention and indicates that beetles are at work in the tree.

Protection and Remedial Measures.

These are fully dealt with under the *Scolytus* bark-borer (p. 572), and they are very similar to those already advocated for the cryptorhynchid weevil of this pine. In plantations they can be put into force with considerable advantage. We know the approximate dates on which we shall find larvae and pupae in the trees, i.e. middle of May, end of July, third week to end of September, and middle of November. Badly infested trees should be cut out and burnt at these periods; the best time would be during winter. If the scolytid is to be dealt with at that season it would be essential that the badly infested trees were marked down in the autumn, as during the winter months the insect is quiescent and there would be little evidence on the external parts of the tree to show that it was badly infested.

Predaceous Insects.

Some of these are dealt with under *Tomicus longifolia*, e.g. a species of Chalcid, a carabid *Tachyta*, the histerids *Niponius* and *Paromalus*, a trogositid *Timnochila*, and the clerid *Thanasimus* (*vide* p. 560). They appear to feed upon this bark-borer as well as upon that pest.

Hypophloeus, sp. nov.—This species of *Hypophloeus* is predaceous on *P. longifolia* in the chir-pine trees. The beetle is described and figured on p. 236.

Life History.—I took this insect very numerously in the galleries of this *Polygraphus* in a recently blown down large green chir pine. The beetles were taken in the middle of October 1906, and were swarming amongst the scolytid larvae in the tree. I was at first of opinion that the insect was feeding on the sap of the tree, but subsequent investigations seem to confirm the statement that the beetle or its grubs are predaceous or semi-predaceous. I took the insect in other localities in Jaunsar.

Polygraphus aterrimus, Strohmeyer.

REFERENCE. Strohmeyer, *Entomol. Wochenbl.* xxv. p. 69 (1908).

Habitat.—North-West Himalaya.

Tree Attacked.—Deodar (*Cedrus deodara*). Kulu.

Strohmeyer had four specimens of this insect sent to him by C. Rost, from Kulu, with the information that they were taken from deodar. I am of opinion that the insect is identical with *Polygraphus major*, but make the statement with reserve, as I have not seen Strohmeyer's specimens.

Tribe CRYPHALINAE.

Differs from the Crypturginae as follows :—

Head round. Elytra not truncate.

This tribe includes the genus *Cryphalus*, containing a number of very minute forms feeding in the bast layer of small branches and twigs of trees, and in the upper portions of saplings.

Cryphalus.

Cryphalus (Cosmoderes) deodara, Stebbing.

(*The Deodar Branchlet Cryphalus.*)

Reference.—Stebbing (*Cryphalus? deodara*), *Depart. Notes*, vol. i, 274.

Habitat.—North-West Himalaya.

Tree Attacked.—Deodar (*Cedrus deodara*). Kotgarh, Bashahr State (*mihi*); Konain, Jaunsar (R. McIntosh).

Description.

Beetle.—Oblong, rather shining, dark red-brown to almost black in colour, covered with sparse stiff whitish-yellow hairs. Head black, concealed by prothorax, which forms a hood over it. Antennae the same colour and of usual *Cryphalus* form. Prothorax not broader than long, the anterior portion rather thickly studded with raised projections, the posterior half being punctate. Elytra about twice the length of prothorax, sides straight, declivous at apex; a longitudinal channel on either side of suture, most marked in apical portion; punctate-striate, the punctures largest and most numerous on basal three-fourths, becoming obsolete apically; the basal portion with irregular transverse striations medianly. Under-surface black. Legs rufous brown. Length about 1.8 mm. (see fig. 340, *a*).

Larva.—A minute, white, curved, fleshy grub of the usual scolytid appearance.

Life History.

The insect would appear to pass through the winter in the beetle stage. The beetles issue from the trees and oviposit early in the spring some time towards the end of April. To perform this operation the beetle seeks out a small green twig and girdles it at or near its base, the girdle being, in every case examined, complete (see fig. 340, *b* (1)).

The insect was discovered in all the stages of larva, pupa, and beetle at the beginning of June in deodar branchlets. The beetles, just about mature and apparently ready to leave the tree, were by far the most numerous. Although the twigs contained these mature beetles, yet externally there were no entrance-holes visible on the bark, and a close inspection showed that the branchlet was girdled at or near its base. This girdle was made by the spring mother-beetle with the object of preventing further sap proceeding up the branchlet, which accordingly begins to die and thus provides a suitable supply of food for the young larvae hatching out from the eggs laid by the beetle in the branch above the girdle. The reason why I think it probable that the branch is girdled and the eggs laid in the spring is that the young new needles of the year had developed on the ringed twig to a

certain extent before they began to wither and die. Further, the wood of the twigs was still comparatively fresh, instead of being dead and rotten, as would have been the case had the ringing been done the previous year. The eggs are laid near the girdle, and the larvae mine up the twig (fig. *b* (2)). On becoming mature, the beetle bores its way out of the branchlet by a short gallery at right angles to its long axis (see fig. *b* (3)).

An examination of many of the persistent dead twigs showed the plan of action of the beetle. Low down near the base was the girdle, above but near to which the egg or eggs are laid. Inside the twig, galleries will be found running up and down the wood, made by the feeding larvae, and on the outside one or more holes of exit show where the beetles have left the stem. The larva apparently mines all round in the outer wood of the twig, leaving a central core, and this, in old twigs, remains often as a small hard splinter, whilst the shell of bark- and wood-powder crumbles to dust under one's fingers. In small twigs I never found more than one beetle, but in the larger several were present, and in large dry attacked twigs I noticed several holes of exit. From this I conclude that in small twigs but one egg is laid, while in the case of larger ones several eggs are deposited under the small flakes of rough bark. Whether these are laid by the same beetle or not has yet to be determined. In fig. *b* (4), a small branch is shown which has been girdled in several places by this beetle. The needles had turned yellow and were dropping off.

I first took this beetle in deodar branchlets at the beginning of June in the Nagkela Forest, Kotgarh, Bashahr Division, at an elevation of about 6,000 feet in the North-West Himalaya. Subsequently it was noticed in several other parts of the division.

It was also independently found about the same time by Mr. R. McIntosh, Deputy Conservator of Forests, at Konain in the Jaunsar Division, some hundred-odd miles to the south-east.

Fig. 340. — *Cryphalus deodara*, Steb. *a*, dorsal and side view of beetle; *b*, deodar branchlets showing method of attack of this insect: 1 the girdle, (2) section of branch showing the larval tunnel, (3) horizontal gallery and exit-hole made by beetle on maturing, 4) branchlet girdled in several places at (1) by this beetle. (*b*, from drawings by the Author.

Relations to the Forest.

As far as present observation goes, this beetle does not bore into the main stem or main side branches of the deodar, but confines its operations to the small upright needle-bearing branchlets borne on the latter, on which a new flush of needles appears in the spring. Under the attack the needles on the infested branchlets turn yellow and wither, and the dying twigs thus become very conspicuous on the trees. Save for this withering, the twigs show no sign of external damage when first looked at. If taken hold of, however, they usually come off in the hand, snapping either from half to one inch or less (or it may be at the juncture itself) from the juncture with the main branch. A close inspection shows that the twig breaks at the point at which it has been ringed. Above the ring the newly attacked branch is seen to be dying, and on cutting it up larvae or beetles will be found within it. This girdling results in short dead stumps of twigs or the dead unfallen twigs themselves being present all up the main branches, and previous attacks can at once be recognized by this characteristic. When the twigs are girdled right at the base, these visible signs are not, however, so apparent. The foliage is seen to be much thinner on the branch, and if such branches are looked at closely the scars will be seen. When the dry twigs are in exposed situations, they soon get knocked off by the wind or by blows from adjacent branches; when, however, they are on portions of the main branch which are more or less sheltered, they may be found persisting in numbers.

The result of this attack, more especially when combined with that of the branch-boring *Stephanoderes himalayensis* beetle (see p. 540), entails a loss to the tree of young needle-bearing twigs, with the consequent decrease in the area of foliage—always a serious matter in the case of a conifer. As I have already said, the yellow rosettes of needles on the branches attacked are evidence of this beetle being at work; but an inspection is always necessary, as there are other insects whose attacks appear to produce much the same result on the tree if only cursorily examined.

Prevention and Remedies.

In the case of ornamental trees and small valuable plantations it would be comparatively easy to get rid of this pest. The attack should be carefully watched, and when the twigs are full of larvae, i.e. about the middle of May, they should be broken off and burnt. Any subsequent generations would be treated in the same manner. At present, however, the beetle has only been found on the larger branches of old trees, and further observation is required to ascertain whether it confines its attacks to the branchlets on old trees.

Cryphalus major, Stebbing.

(*The Long-needled Pine Larger Cryphalus.*)

REFERENCE.—Stebbing, *Depart. Notes*, vol. i, 270.

Habitat.—North-West Himalaya.

Tree Attacked.—Chir Pine (*Pinus longifolia*). Tons Valley, etc., Jaunsar.

Description.

Beetle.—General colour black or brown; surface densely clothed with light yellow hairs. The club of antenna is oval, narrower above, and with four articulations. Funiculus is five-jointed. Thorax slightly broader than long. The male and female are, I think, of different colours.

♂ Yellowish brown in colour. Thorax with prominent spiky spines on its upper two-thirds. The lower third and elytra pitted. Insect covered with whitish hairs.

♀ Black, shining, the upper two-thirds of prothorax with a dense pitted mass of yellow hairs and with a few spiky spines. Lower third of prothorax and the elytra pitted and clothed with dense short yellow hairs and a few lighter-coloured longer ones. Length, $\frac{1}{16}$ in. In the specimens obtained the ♀ appears to be somewhat larger than the ♂. Fig. 341, *a*, *b*, shows the ♂ and ♀ of this insect.

Life History.

This beetle is the larger of the two species of *Cryphalus* which have been found attacking the *Pinus longifolia*. It is often to be found in the smaller twigs of the tree in company with its more minute companion *Cryphalus longifolia*, Stebbing; but it occupies a lower part of these branches and also attacks

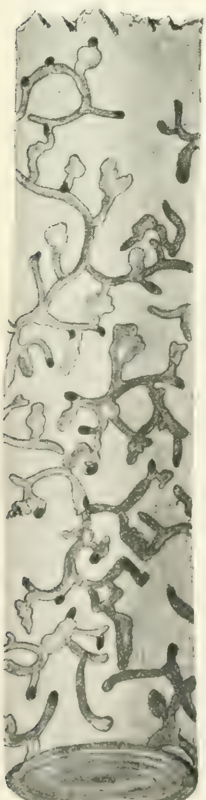


FIG. 341.—*Cryphalus major*, Steb. *a*, dorsal and side view of male beetle; *b*, dorsal and side view of female beetle; *c*, attacked *Pinus longifolia* branchlets showing (*p*) the pairing chamber, (*f*) the horizontal tunnel down to the pith, and (*e*) the egg-gallery; *d*, larger branchlet showing the same as *c*; *g*, piece of a larger *P. longifolia* branch severely attacked by this beetle, showing how the galleries run into one another and become indecipherable on such occasions. N.W. Himalaya. (Fig. *c*, *d*, *g*, from drawings by Author.

the main stem as well as the side branches of saplings. It apparently prefers dying but still green trees.

The insect is to be found at the end of the first week in June burrowing into branches of old trees to oviposit. A shallow irregular-shaped chamber is first bored in the sapwood beneath the bark, both ♂ and ♀ beetles taking their share in this work, both having

entered the tree by the same hole (see fig. 341, *c*, *d* (*p*)). After the preparation of this chamber, it is probable that fertilization takes place and the ♂ beetle then leaves the tree to die. When attacking small branches the ♀ now bores a tunnel vertically down into the sapwood, either at the centre or in a corner of the pairing-chamber (fig. *c*, *d* (*f*)), until it reaches the pith of the branch; she then mines out a gallery (fig. *c*, *d* (*e*)) running in the longitudinal axis of the branch, and at right angles to her former direction, about half an inch in length on either side of the vertical bore. The eggs, I think, are probably laid in this tunnel, and the larvae perhaps mine up and down both ways, but this latter has to be corroborated by further observations. In one or two instances it was noticed that the ends of the gallery in the pith were blocked up with plugs of what appeared to be chewed-up pith, in which the eggs may have been laid. When the female is disturbed in the pairing-chamber, in which she apparently lives for some time after egg-laying, she at once retires down into the gallery in the pith by the vertical boring (*f*). In the case of larger branches only the hole at one side of the pairing-chamber and the egg-galleries, which are usually curved and branching, deeply groove the sapwood (see fig. *g*). Indentations at irregular intervals are cut in the sides of the egg-gallery, in which the eggs are laid. The larvae feed almost entirely in the bast in which the larval galleries are bored. Fig. *g* shows a portion of a branch badly attacked by this pest in which the galleries are so interlaced as to render it difficult to decipher them. This is the usual appearance of old attacks in the forest.

As this *Cryphalus* lives at a somewhat low elevation in hot valleys (the altitudes at which it was found were between 2,500 and 3,000 ft.), it is probable that the June beetles observed egg-laying were laying the eggs of the second generation of the year. Just a month later, however, in the first week in July, the beetles were observed again egg-laying, this time all the pairing-galleries and many of the mother egg-galleries having been already prepared. No ♂ beetles were found at this period. This means that either the June-July generation is run through in all its stages in a month, or (what is perhaps more probable) that there are several generations of these insects in the year and that the different life-cycles overlap.

From some branches taken down to Dehra (elevation 2,000 ft.) I bred out beetles in the middle and third week of September, and others about the end of the first week of October.

Damage Committed in the Forest.

This is a more dangerous pest than its smaller companion *Cryphalus*, since its galleries and boring operations are on a more extensive scale. Saplings and branches of older trees heavily attacked by the beetle lose their needles, which first turn yellow and then drop off. An examination will show circular entrance-holes large in comparison with the minute ones of the smaller *Cryphalus*, and these will be seen to be equally as numerous on the outer surfaces of the thicker bark as in the interstices between the flakes. The

beetle would seem to prefer dying or sickly trees for its operations, and it was noticed in some abundance in portions of a forest which had been overrun by fire the previous season. The tops of many young saplings were infested with the small *Cryphalus* and less numerously with this one. Lower down, however, the larger one was much more numerous, many of the stems being entirely riddled by the beetles.

The beetle, since it is, as far as present observations go, invariably accompanied by *Cryphalus longifolia*, and often by *Polygraphus longifolia* as well, must be considered a serious pest in young plantations, and its life history requires fully working out.

Protection and Remedies.

Cut out and burn all young infested saplings. They may be easily recognized, as the somewhat heavy foliage of the long-needled pine turns a bright yellow under heavy attacks, and the trees thus become very conspicuous.

Areas which have been overrun by fire or on which sickly trees are noted to exist should be carefully watched, the trees being inspected as often as possible for external shot-holes. Trees with these appearing on them should be allowed to remain for a week or two until the beetles about have all oviposited in them, when they should be cut out and burnt.

During severe attacks trap trees (see p. 573) should be prepared.

Cryphalus longifolia, Stebbing.

(The Long-needled Pine Smaller Cryphalus.)

REFERENCE.—Stebbing, *Depart. Notes*, vol. i, 267.

Habitat.—North-West Himalaya.

Tree Attacked.—Chir Pine (*Pinus longifolia*). Jaunsar and Bashahr State (2,000 to 3,000 ft.).

Description.

Beetle.—A minute insect, yellow to dark brown in colour, and clothed with a fairly dense mass of long whitish or whitish-yellow hairs. Head with vertex smooth, shining, and very finely punctate; front clothed with longish yellow hairs. Antennae and legs bright yellow. Head hidden by the thorax. Mandibles short. Scape of antennae thickened anteriorly, funiculus of four joints, the first large, longish; club flattened and oval. Prothorax wider than long, convex dorsally, armed with small spiny tubercles anteriorly. Elytra cylindrical, rounded at their posterior declivities, not wider than the thorax. Tibiae finely toothed on their outside edges. Tarsus with joints 1 to 3 of equal length. Body cylindrical. Length, 1 mm. or a little over Fig. 342, *a*, shows a dorsal and side view of this insect.

Life History.

The beetle appears on the wing at the end of May and beginning of June, and tunnels into the branches of old trees or into the tops and branches of young saplings for ovipositing purposes. Green sickly branches and half-dry ones appear to be chosen for egg-laying. The May-June generation of the beetle, which was the first one discovered, probably lays the eggs of the second generation of the year, the eggs of the first generation being laid some time at the end of March or early in April.

In boring into a branch this *Cryphalus* never goes in direct from the outside, but always searches out some small flake of bark beneath which to bore its entrance-hole. The bark of the *Pinus longifolia* is rough even on small twigs, and so it has no difficulty in making its entrance into the branch unobserved. On reaching the bast layer a small irregular-shaped chamber is bored by the beetles, indenting both sapwood and bast (see fig. 342, *b*, *c* (*p*)). I have always found two beetles at work making this excavation, and never more than two, the male helping the female. I am unable to say whether pairing takes place before or after this chamber is complete, but as soon as there is room in it for the two beetles, two will be found together. Round the sides of the chamber little indentations are cut (fig. *b* (*e*)). By the time the shallow excavation is complete it has become full of white powdery wood-dust, and the eggs are laid either loosely in this or in the indentations. At this period only one beetle is present in the egg-chamber. Galleries were found in this condition at the beginning of July. Further than this I have not as yet been able to carry the life history, but from an examination of old twigs and branches it appears that the larvae mine outwinding galleries in the bast and sapwood as shown in fig. *c* (*l*).

There is at least a third and possibly a fourth generation of the beetle in the year. From some branches taken to Dehra the writer bred out beetles in the middle of September, and others may have issued in August, since dead beetles were found in the breeding-box, which owing to absence on tour was not opened in that month.

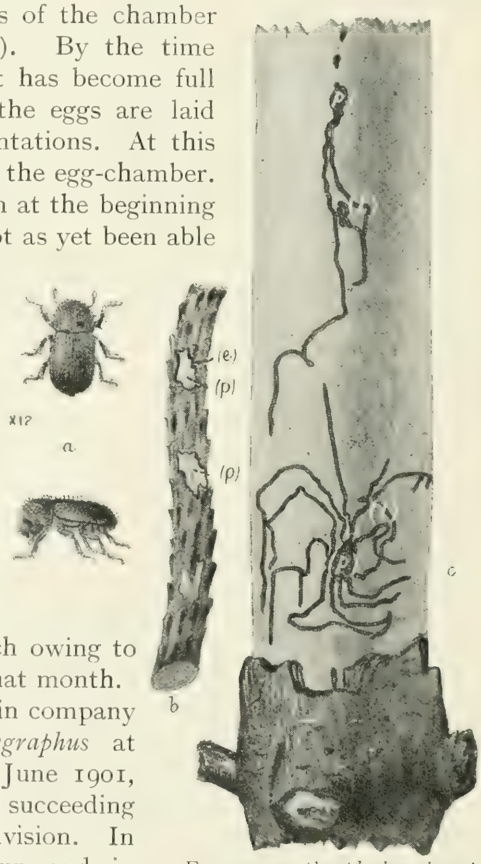


FIG. 342.—*Cryphalus longifolia*, Steb. *a*, dorsal and side view of the beetle; *b*, portion of a *Pinus longifolia* branchlet showing (*p*) pairing-chamber with (*e*) the indentations made to enlarge it to deposit the eggs; *c*, portion of a branch showing (*p*) the pairing- and egg-chamber, (*l*) the larval galleries. N.W. Himalaya.

The beetle was first discovered in company with the long-needled pine *Polygraphus* at Taklesh in the Bashahr State in June 1901, being obtained the following and succeeding years numerously in the Jaunsar Division. In 1908 I noted its attacks in Kumaun and in 1909 in Chamba.

Relations to the Forest.

This beetle, though very minute, has the power of increasing in large numbers, and must therefore be included amongst the pests of the pine. It infests the main stem of seedlings and small saplings and the smaller

branches and twigs of older trees, the cambium layer being entirely riddled by the borings of the beetles themselves and by the subsequent minings of the larvae, which practically girdle the top or twig attacked, consequently ensuring its death. As I have already mentioned, it is often accompanied lower down the top or branch by the *Polygraphus* and by *Cryphalus major*, both more serious scolytid pests.

Prevention and Remedies.

All young saplings infested should be cut out and burnt. In nurseries and small plantations, attacked branches should be pruned close to the stem and burnt. The attack is easily discernible when the beetle is present in numbers (more especially when in company of either of the above-mentioned beetles), as the needles turn yellow and there is an exudation of resin from the entrance-holes.

Cryphalus morinda, Stebbing.

REFERENCE.—Stebbing, *Depart. Notes*, i, 265.

Habitat.—North-West Himalaya.

Tree Attacked.—Spruce (*Picea morinda*). Simla-Tibet Road, Bashahr.

Beetle.—Very small, cylindrical. Really black in colour, but so thickly set with a dense, close, golden pubescence as to have the latter colour. The upper three-quarters of the prothorax

Description.

slopes rather abruptly in front, and is thickly studded here with prominent tubercular prominences. Posterior quarter is finely pitted. Elytra finely punctate. Antennae and legs yellow-brown. Under-surface black, set with long white hairs. The ordinary characteristics of a *Cryphalus* as given under *C. boswelliae* are present. Length, $\frac{1}{16}$ in.

FIG. 343.
Cryphalus morinda, Steb., in spruce. North-West Himalaya.

Life History.

The flight-time of this beetle is from about the second to the third week in June. The beetle commences work by boring in through the bark of a twig till it reaches the cambium layer. In this it then bores a small chamber which also goes slightly into the sapwood. Whilst this is being prepared another beetle joins the first, and in the narrow, small, elliptical chamber two beetles will generally be found at work as soon as the boring is sufficiently large to hold both. In this elliptical chamber the eggs are laid. The beetle is apparently monogamous in its habits, the male pairing with but one female. The grubs on hatching eat out a shallow gallery away from the chamber, this joint larval gallery gradually increasing in breadth with the development in growth of the grubs.

The insect infests the twigs and smaller branches only of old spruce, the twigs drying up and the needles turning yellow under the attack. This is as far as the life history of this minute insect has been carried.

Damage Committed in the Forest.

Very little is known about these small cryphalids in India, and it is therefore impossible to state here the relation they really bear to the forests. I cannot at present say whether this beetle is abundant or not, nor whether it attacks young growth as well as old trees. It has only been found in the latter to my knowledge up to date. It is probable that it usually searches for branches which are weak in health; but examination of dead branches shows that those which it attacks in any numbers it invariably kills. The cambium is entirely eaten away by the larvae, the latter being responsible for the greater part of the damage done. A certain amount of thinning-out of the smaller branches and shortening of the older ones must take place on the tree under the operations of this insect. If young growth is attacked leaders may be killed by the beetle.

Cryphalus tectonae, Stebbing.

REFERENCE.—Stebbing, *Depart. Notes*, i, 263.

Habitat.—Berar.

Tree Attacked.—Teak (*Tectona grandis*). Melghat Forest, Berar.

Description.

Beetle.—Smaller than *Cryphalus boswelliae.* Cylindrical. Head, prothorax, and elytra a reddish brown in colour, and covered with rather scattered short yellow hairs, which are set in rows on the elytra. The prothorax set with tubercular projections anteriorly, and lightly pitted posteriorly. Elytra fairly finely striate and punctate, with parallel rows of short yellow hairs running down them. Antennae and legs bright yellowish-brown. Undersurface set with longish tufts of white hairs placed irregularly. Length, 1.2 mm.

FIG. 344.

Cryphalus tectonae, Steb., in teak. Berar.

Larva.—The grub of this beetle is very small, white, curved, and has no legs.

Life History.

The flight-time of this insect is about the latter half of July in this part of India (Berar). The beetle would appear to have the same habits as other minute *Cryphali* in the continent. It bores into a branch until it reaches the cambium layer, and then mines out in this and the sapwood a small chamber, being then joined by a companion. They then together eat out the egg-gallery, which is simply an irregular-shaped small chamber made in the bast and sapwood, in which the eggs are laid amongst a small mass of wood-dust.

In one case I found a larva, and it would seem therefore probable that the beetles commence egg-laying about the beginning of July in Berar, and that only a few days are passed in the egg stage, the larvae hatching out within a very short time. This minute beetle was discovered boring into the smaller branches of the teak-tree in Berar in July 1901. This is at present all that has been observed on the habits of this minute beetle.

Little is known about this *Cryphalus*. I am unable to say whether it is at all abundant or otherwise in the teak forests of the country. It has at present only been found on old trees. Owing to its method of attack, under which the cambium of the young shoot is destroyed by it and its larvae, it is obvious that if it should attack young growth and were to infest it in any numbers, it would be capable of doing serious injury. It will perhaps be found most abundant in localities where the teak is of inferior growth.

Relations to the Forest.

Cryphalus boswelliae, Stebbing.

REFERENCE.—Stebbing, *Depart. Notes*, i, 261.

Habitat.—Poona, Bombay Presidency.

Tree Attacked.—*Boswellia serrata*. Bhamburda Reserve, Poona.

Beetle.—Short, elliptical, black, clothed with a very short yellowish pubescence on prothorax and elytra. Head and thorax pitted. Elytra with striae and wide rows of bluish-white punctures between them. Mandibles short. A brush of yellow hairs round the mouth. Scape of the antennae, which are dark brown, long, club-shaped ; funiculus four-jointed, the first joint thick, elongated, the second to fourth only slightly increasing in size ; club flattened, oval. Eyes long, narrow, transverse. Prothorax not longer than broad, narrower in front than behind, more or less uniformly punctate, with punctures and not tubercular projections anteriorly. Elytra cylindrical, rounded on their posterior declivity ; not wider, or only very slightly so, than prothorax, slightly bending inwards at their base. Legs dark brown. Tibiae curved, and finely toothed on their exterior edges ; tarsus yellow, with the first three joints of equal length. Length, just over $\frac{1}{18}$ in. Fig. 345, *c*.

Description.

Larva.—A small, white, curved, legless grub. Fig. *a*.

Pupa.—White, unenclosed in any cocoon or covering, the antennae, wings, and legs being quite free, and held close to sides of the beetle. Fig. *b*.

FIG. 345. *Cryphalus boswelliae*, Steb., in *Boswellia serrata*. Poona.

Life History.

The flight-time of this beetle is about the beginning of August, and probably for some time later. The insect, in all stages of its life, is to be found at the beginning of the month. In branches of the *Boswellia* which appeared to be dying but were still green, larvae were plentiful, and also pupae and light-coloured beetles, the latter not quite mature. The larvae are to be found in irregular-shaped cavities in the bast and sapwood, which usually contain a certain amount of moist wood-dust. In the pupal and beetle stages this latter becomes dry. In other branches darker-coloured beetles were present, and these were apparently the mature beetles of this generation which had already begun egg-laying. The ♂ and ♀

beetles were found together gnawing out irregular-shaped chambers beneath the bark in the bast and sapwood. These beetles had apparently only just matured, and had at once commenced egg-laying, the eggs being those of a second or third (?) generation. This is all that has been at present observed about this insect.

Damage Committed in the Forest.

The smaller green branches of *Boswellia serrata* are bored into by the insect for the purpose of laying its eggs in them. The larvae, on hatching out, feed upon the surrounding cambium layer and destroy it. If at all plentiful, the bark is eaten right round, and the twig, being girdled, dies.

Further observation is required to ascertain whether the insect is at all numerous, and whether it infests young plants. In this latter case it might on occasions become a serious pest.

Cryphalus strohmeyeri, Stebbing.

REFERENCE.—Stebbing, *Cryphalus indicus*, *Depart. Notes*, i, 403.

Habitat.—North-West Himalaya.

Tree Attacked.—Silver Fir (*Abies webbiana*). Jaunsar, North-West Himalaya.

Description.

Beetle.—Cylindrical, black, with a pubescence varying from yellow to silvery and reddish. Head hidden beneath thorax. Antennae reddish yellow, angled, the scape club-shaped, the funiculus four-jointed, the first joint thick, others subequal; club oval, divided into four divisions by three transverse lines. Thorax not longer than broad, very convex, narrower in front than behind, the anterior three-fourths furnished with prominent, acute, tubercular projections set backwards, the basal portion, especially laterally, clothed with long yellow hairs. Elytra cylindrical, constricted and rounded posteriorly, very slightly wider than thorax; coarsely and irregularly rugulose and punctate, and covered with a squamulose pubescence consisting of longitudinal rows of short silvery and reddish hairs. Legs reddish brown, pubescent; tibiae curved, and toothed on outer edge, clothed with a dense yellow pubescence; tarsi yellowish, first three joints equal. Length, 2.3 mm.

I find *C. indicus* is preoccupied, so have pleasure in naming this species after Herr Oberförster Strohmeyer.

Egg.—White, oval, translucent.

Larva.—Small, white, curved, and legless, with a yellowish head and brown mandibles.

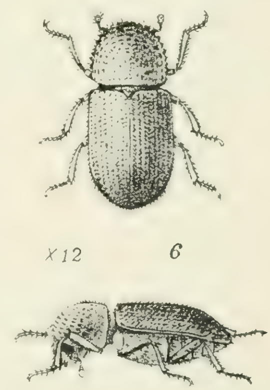


FIG. 346. *Cryphalus strohmeyeri*, Steb., in silver fir. North-West Himalaya.

Life History.

The flight-time of the first beetles of the year is about the middle of May, at elevations of 8,000 ft. I took the beetle in the fourth week of the month laying eggs in green silver-fir branches. Either masses of eggs or young larvae were found in the egg-chambers, the beetles having evidently been some days at

work. Infested branches contained numerous beetles, and appeared to die upwards from the lowest part affected.

The beetle enters the branch by boring a horizontal tunnel through the bark to the bast, preferably just at or below the juncture of the branch with the stem; though, if these places are already occupied, it will go in anywhere else on the branch. On reaching the bast the insect eats out in the bark and sapwood a shallow chamber, in which the eggs are deposited amongst a mass of chewed wood-dust. These eggs are laid in little masses, apparently stuck together, on one or two sides of the chamber. In the case of the observed Indian cryphalids it appears to be usual for the male insect to help the female in preparing this chamber; but I do not know whether this is the case in this instance, as the attack was too far advanced when discovered. As soon as the eggs are laid the female appears to leave the chamber, going out by the hole at which she entered. The larvae, on hatching out, feed upon the bast layer at the edges of the chamber; not boring definite tunnels away from it, but just eating away the edges in an irregular manner.

From observations made on the habits of other species, it is not unlikely that there is at least one more generation of this insect in the year, the beetles from the May larvae probably appearing in July and ovipositing in fresh twigs and branches. This fact and the rest of the life history of the beetle have, however, yet to be observed.

Relations to the Forest.

C. strohmeyeri has only been found as yet in green silver-fir branches of old trees. It is probable that it infests branches of trees of all ages. In several instances the beetles have been found killed in their entrance-tunnels by an outflow of resin from the living branch. If the beetles are at all numerous the branch is often killed; and this may be the case when only a few insects infest it, since the feeding of the larvae by continually enlarging the original egg-chamber often completely rings the branch, the cambium being eaten away all round. The needles on infested branches turn bright yellow and die, and thus the presence of the pest can be easily recognized at a distance. A closer examination will show on the branches small round holes, surrounded by small circular rings of resin.

It is not yet known whether this insect infests the leading shoots and branches of young saplings.

Protection and Remedies.

In ornamental plantations in stations and cantonments, etc., remove all infested branches and burn them. This should be done in the early part of June. If young growth is affected, all trees found attacked by the pest should be promptly cut out and burnt.

Cryphalus (Stephanoderes) himalayensis, Steb., sp. nov.

REFERENCE—Stebbing (*Hypoborus* ?), *Depart. Notes*, vol. i, p. 278.

Habitat.—Jaunsar, Simla Forests, North-West Himalaya.

Tree Attacked.—Deodar (*Cedrus deodara*). Jaunsar, Simla Forests.

Description.

Beetle.—Small, oblong, shining, dark ferruginous to almost black, at times lighter in colour. Shaft of antennae and legs yellowish brown, tarsi and antennal club yellow. Front of head rather coarsely punctate, the vertex finely and transversely striate. Prothorax slightly wider than long, sides constricted anteriorly, slightly dilated before base, rounded, the basal angles rounded ; anterior margin tuberculate, surface raised towards middle and coarsely tuberculate, tubercules decreasing in size posteriorly, posterior fourth with rather large shallow punctures becoming less distinct laterally ; surface sparsely set with short stiff whitish-yellow hairs. Elytra more than half as long again as thorax, smooth, shining, sub-cylindrical, sides constricted from apical fourth, declivous apically, apices separately rounded ; punctate, the punctures small, placed in rows with wide smooth intervals, least prominent basally ; declivity somewhat convex, smooth with a few scattered fine punctures. Under-surface set with a fine yellowish pubescence. The anterior femora in some cases yellow. Length, 1.5 mm. to 1.7 mm. Fig. 347, *b*.

Larva.—The larva is a very small, white, legless grub (fig. *a*).

FIG. 347.—*Cryphalus himalayensis*, Steb., sp. nov. *a*, larva ; *b*, dorsal and side view of the beetle ; *c*, branch with bark removed showing *p* the pairing-chamber, (*l*) larval galleries, and *m* the pupating-chambers of larvae. N.W. Himalaya.

Life History.

The male beetle bores horizontally through the bark down to the cambium layer, usually just below the junction of two branches, and hollows out a small irregular-shaped pairing-chamber in the bast and sapwood. As many as three female beetles successively enter by the same hole and pair with the male. After pairing, the female beetles do not bore out a definite egg-gallery away from the pairing-chamber, but merely enlarge this latter by eating out the bast and sapwood on one side or the other, successive beetles commencing work at opposite sides and laying their eggs in the area so enlarged. The whole of this irregular-shaped gallery made by the beetles, which often entirely encircles the branch beneath the bark and extends up the forks of the branches and thus effectually rings the tree, is filled with a wet mass of chewed wood-refuse and excreta, amongst which the eggs are laid (*vide* fig. *c*). The egg stage is short, two to four days only, since young larvae are often found in the chamber near the living female beetles and in the wood-dust.

The larvae bore away from the central chamber either up or down the stem, their galleries being blocked up with wood-dust and excreta. When full-fed they hollow out at the end of the gallery a longish chamber in the sapwood and pupate in it (fig. *c*).

I have taken mature beetles ovipositing in deodar-trees in the first week of June (1902), and this may be the first generation of the year.

At the beginning of November 1906 I took another generation of these beetles tunnelling into branches to oviposit. It is therefore probable that the insect passes through the winter in the larval or immature-beetle stage.

I am unable to say whether the insect passes through a complete life-cycle between July and the end of October. It is possible that the June eggs give rise to a generation of beetles issuing in the latter part of July or in August, and that these beetles lay the eggs which produce the October generation of beetles.

Damage Committed in the Forest.

Since the insect only feeds in green cambium and its method of oviposition often results in the branches being girdled, it is capable of proving a serious pest to young trees; the more so that whenever I have met it it has been in considerable abundance, the beetle apparently being a particularly hardy one.

The curious fact that it is almost invariably found infesting the upper part of branches already girdled by the *Scolytus* deodar girdler is of importance, since it is necessary to discriminate between this insect in this position and the real perpetrator of the damage, the *Scolytus* beetle. The fact that it chooses this position also minimizes to some extent the damage it does in the forest.

Protection and Remedial Measures.

When the insect is found infesting young growth the only safe plan of combating it is to wait till it is in the nearly full-grown larval stage in the trees, and then to cut out these latter and burn them. Infested trees can be easily recognized by the fact that the needles turn yellow and drop off, and rings of resin are to be seen beneath and encircling the minute shot-holes made by the beetle entering the trees.

Ichneumon sp.—A small black fly with membranous wings; the antennae eleven-jointed, bent, the upper part with a white pubescence.

Parasitic Insect.

A specimen of this parasite was taken from a pupal chamber of the larvae of this *Cryphalus* in a deodar twig. The scolytid grub had evidently lived to reach full size and eat out its pupal chamber and had then died; the Ichneumon grub, which had parasitized it, then pupating in the scolytid pupal chamber.

Cryphalus sp.

Habitat.—Siwaliks, Dehra Dun, North India.

Tree Attacked.—*Erythrina suberosa.* Bulawala, Dehra Dun (B. Sen Gupta).

Description.

Beetle.—Short, elliptical. Light greenish yellow with a short spiny yellow pubescence. Head hidden beneath the hood-like prothorax, punctate; antennae yellow, club brown. Prothorax with anterior margin rounded and tuberculate, disk very convex medianly; anterior three-fourths roughly tuberculate and asperate, the tubercles placed at regular relatively wide intervals on anterior portion, closing up behind; posterior fourth finely rugose-punctate. Elytra rugose and striate, the sides straight, declivous apically; rather closely covered with short coarse spiny hairs Under-surface and legs yellow, punctate, pubescent. Length 1.5 mm. The only specimen I have seen is in too poor condition to enable the species to be described in detail.

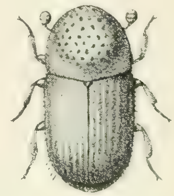


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FIG. 348.
Cryphalus sp. in *Erythrina suberosa.* Siwaliks.

Life History.

Specimens of this minute scolytid were taken from galleries beneath the bark in the bast of a felled and recently dead *Erythrina suberosa* tree in the middle of February 1902 by Babu B. Sen Gupta, at the time a student at the Imperial Forest School at Dehra Dun. The beetles were almost mature and ready to issue in the spring. They originated from eggs laid by the last generation of the insects, which probably oviposited some time in the autumn of 1901.

Cryphalus sp.

Habitat.—Jaunsar, North-West Himalaya.

Tree Attacked.—Ban Oak (*Quercus incana*). Kathian, Jaunsar.

Beetle.—Black, clothed with a long white pubescence. The insects taken were in a poor state of preservation.

Life History.

I cut out three specimens of this insect from galleries on the inner side of the bark of a dead fallen oak-tree. Two of the three beetles so taken on 6 July 1902 were fully mature, the other was lighter-coloured and immature. All three beetles were dead. Beyond the fact that this insect infests this tree and its grubs feed in the bast layer, as was evidenced by their excavations, nothing appears known.

Cryphalus (Hypothenemus) mangiferae, Stebbing.

REFERENCE.—Steb., *Ind. Mus. Notes* (*Hypothenemus* sp.), vi, 1, p. 68 (1903).

Habitat.—Eastern Dun, United Provinces.

Tree Attacked.—Mango (*Mangifera indica*). Eastern Dun, Siwaliks.

FIG. 349. — *Cryphalus mangiferae*, Steb. 2, *2a*, beetle ; *2b*, *2c*, antenna and leg ; *2d*, larva. Siwaliks.

Beetle.—Minute, brown. Head concealed by prothorax. Latter very convex on disk, sloping forward anteriorly and posteriorly ; finely punctate. Elytra moderately convex on disk ; uniformly striate-punctate ; the apex leaves a small portion of last abdominal segment exposed ; abdomen inflexed posteriorly. Length, 3 mm.

Description.

Larva.—Small, elongate, white, with a brownish head. Thickest anteriorly just behind the head, the abdominal segments of much less width ; spiracles prominent laterally. Length, 3 mm.

Life History.

This small scolytid only attacks the green shoots of the mango, the eggs being laid in the bast layer of the twig. The insect's presence can readily be detected owing to the fact that black patches appear on the green cortex. Above these patches the leaves on the twig will be seen to be turning yellow, and they die and drop off. Beetles just mature and a few larvae were found in the twigs on 11 May 1902, the beetles being probably the first generation of the year. It is probable that there are one or two more life-cycles during the year. The insect proved new to the British and Indian Museum collections. It was taken with *Dinoderus distinctus* (see p. 129).

Tribe TOMICINAE (IPINAE).

Differs from *Crypturginae* and *Cryphalinae* in having the elytral declivity truncate and armed.

The tribe includes the important genus *Tomicus* (*Ips*), containing some serious Himalayan coniferous pests. Also the genera *Coccotrypes*, *Dryocoetes*, *Pityophthorus*, and *Pityogenes*.

COCCOTRYPES.

Coccotrypes integer, Eichhoff.

REFERENCES.—Eichhoff, *Ratio Tomic.* 311 (1879) ; Stebbing (*Xyleborus*), Assam Sal Ins. Pes. *Ind. For. Bull.* no. 10, p. 62 (1907).

Habitat.—Ceylon ; Assam.

Trees Attacked.—Ebony (*Diospyros ebenum*) : E. E. Green ; Sál (*Shorea robusta*) : Goalpara, Assam.

Description.

Beetle.—Oval, convex. Prothorax black, elytra red-brown. Head punctate. Prothorax longer than broad, semi-elliptical, base truncate, anterior margin rounded, surface punctate, moderately shining, with rather fine asperations here and there. Elytra slightly wider than prothorax at base, from quarter to one-fifth longer ; base straight, sides slightly constricting to apex, which is rounded ; disk rather flat, sides rounded

FIG. 350.
Coccotrypes integer, Eich. Infests sál-seed in Assam.

laterally; punctate, the punctures of varying size and containing setae, placed in rows, the interspaces smooth. Legs ferruginous brown. Length, 1.4 mm.

Larva.—Minute, white, curved, legless, with the segments corrugated.

Life History.

It has often been noticed and commented upon by those travelling through, or living near, tracts of sál forest in parts of the country, that minute brown beetles are extremely plentiful in the cold-weather months, especially January and a portion of February. I have seen them plentifully year after year in the Chota Nagpur sál areas, and Mr. Perrée informs me that they are equally plentiful in Goalpara. These insects are everywhere, and get into the food, being often found inside loaves of bread, etc. It has been surmised that they come from the flour of which the bread is made. The insect is a minute scolytid, and is, I think, the species which I found in sál-seed in Assam in 1906. There is no previous record of a beetle of this nature infesting the seed of this tree.

Specimens of the beetle were first cut out of fallen sál-seed in the third week of May.

The egg is laid in or near the flower, and the young grub mines into the newly forming seed, and remains feeding upon the seed substance until full-grown, when it pupates within the hollowed-out seed case. On maturing, the beetle bores a round hole through the seed-skin and escapes. The eggs probably hatch out about March, the grub maturing at the end of April or first week in May. Beetles were cut out of seeds on 21 May 1906. The insect would not appear to have been very abundant that year. From a basketful of seed examined only six mature beetles were taken, each in a separate seed. It is possible, however, that the time of issuing had not arrived.

Specimens of this scolytid were forwarded to Mr. W. F. Blandford by Mr. E. E. Green from Ceylon. Mr. Green reported that they caused serious injury to ebony-seed.

Damage Committed in the Forest.

The damage done by this grub and other seed-miners is usually of a similar nature, the interior of the seed being partially or entirely hollowed out. Under the attacks the seed is completely destroyed. Pests of this kind require very careful study, since there can be little doubt that one of the reasons, and probably the chief one, why there is so little reproduction in many of the forests under fire-protected management, is the immense increase in the numbers of these pernicious seed-attacking insect pests. Before the introduction of fire protection, fires overran wide extents of forest-covered lands, these fires often occurring at the period of maturity of the seed or just before. In this way insects living in the manner of these sál pests were burnt off in large numbers, since at the time of the fire they were either in the seed on the ground or had left it to pupate in the soil.

There can be little doubt that these seed destroyers are increasing to a serious extent in fire-protected forests.

Methods of Protection.

In case of severe attacks of these pests in areas where natural regeneration is urgently required, I would recommend the use of fire. When a severe attack is in progress a careful watch should be kept over the area affected, and when the maximum number of infested seeds have fallen to the ground the undergrowth should be fired. In Assam this period would be about the first week or so in June. This firing would kill off large numbers of the pests, and would thus enable next year's crop of seed to reach maturity. This suggestion could fall in with the experiments conducted by Mr. Perrée in Goalpara in 1905–6 in firing areas to get rid of the dense undergrowth, grass, etc., with the object of obtaining natural regeneration.

Coccotrypes sp.

Habitat.—South Malabar, Madras.

Tree Attacked.—Teak (*Tectona grandis*). Nilumbur Teak Plantations, South Malabar.

Beetle.—The only specimen taken was in too poor a state of preservation to make it possible to determine whether it is *C. integer* or other known species of the genus

I cut a specimen of this scolytid out of a green dying branch of a teak-pole. The beetle oviposits in the bast layer and sapwood, the grubs feeding in the bast only.

Dryocoetes.

A species of some importance infests the oak in the North-West Himalaya.

Dryocoetes hewetti, Stebbing.

References.—Stebbing, Some Undescr. Scolyt. *Ind. For. Mem.* Zool. Ser. vol. i, pt. i, p. 11 (1908); id. Ins. Pes. Himal. Oaks, *Ind. For. Records*, vol. ii, pt. 1, 15 (1909).

Habitat.—Kumaun, North-West Himalaya.

Trees Attacked.—Moru Oak (*Quercus dilatata*), Ban Oak (*Quercus incana*). Naini Tal and Kumaun Oak Forests.

Description.

Beetle.—A small oblong black insect with a reddish-chestnut tinge. Head with front slightly convex, shining, punctate, very finely transversely striate at sides, with long scattered hairs on front and a fringe of hairs on mouth. Prothorax slightly broader than long, base truncate, humeral angles rounded, sides and apex forming a blunt ellipse ; surface convex, raised into a point medianly and depressed posteriorly ; granulose, the granulations coarse on anterior half, especially on disk, and much finer posteriorly. Scutellum rather large, shining, convex, rounded. Elytra slightly broader apically than prothorax and a fourth as long again ; truncate at base, apex strongly rounded ; surface shining, flat medianly and strongly declivous apically, the declivity shining and edged with long spiny hairs ; rest of surface with rows of punctures which are fine basally and laterally and confluent and rugose medianly. Under-surface lighter reddish-brown medianly, with longish hairs dense laterally. Length, 2.5 mm. to 3 mm.

Figs. 2, 2 *a* show the dorsal and side views of the female beetle; 2 *b*, 2 *c* the same of the male beetle; 2 *d* shows the antenna enlarged; and 2 *e* a leg.

Larva.—A small white elongate worm with a yellowish head. The grub, instead of being curved as is usual with bark-boring scolytid grubs, is more or less straight, and tapers slightly posteriorly. Fig. 1 shows the larva.

Pupa.—Whitish yellow, with ordinary beetle shape.

Life History.

The following notes on the life history are compiled from observations made in the field during the latter half of May and the first half of June 1908. The life history of the insect for the remainder of the year is at present unknown.

The male insect flies to and settles on the outer bark of the oak-tree, and then bores into the bark, eating out a straight tunnel, of the same diameter as itself, down to the bast layer and sapwood of the tree. On reaching the latter it gnaws out a small chamber which grooves both the bast and sapwood and is squarish in appearance (pl. lii). When this work is complete, or before the male has finished the pairing-chamber, a female enters the orifice of the entrance-tunnel of the male in the bark and works her way downwards, enlarging the tunnel as she goes in (as she is larger in circumference than the male), till she reaches the male in the pairing chamber. After pairing with the male the female commences to eat out a gallery in the sapwood and bast; this gallery takes a direction away from the pairing-chamber, and is always more or less at right angles to the long axis of the tree (pl. lii), in this differing from other Indian Scolytidae,* in which the gallery bored by the female is parallel to the long axis of the tree. As she eats out this tunnel, the female makes little indentations in the edges on both sides and places an egg in each. When she has completed the gallery, which is the egg-gallery, i.e. when she has laid all her eggs, she dies *in situ* at the head of the gallery. Before the gallery is completed, however, the larvae from the first-laid eggs

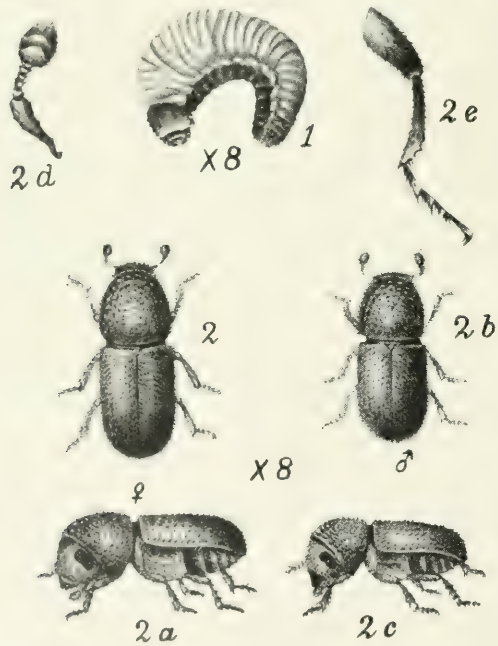


FIG. 351.—*Dryocoetes Hewetti*, Steb. 1, larva; 2, 2 *a*, female; 2 *b*, 2 *c*, male beetle; 2 *d*, enlarged antenna; 2 *e*, leg. North-West Himalaya.

* *Scolytus major*, *Polygraphus major*, *Sphaerotrypes siwalikensis*, etc.

Dryocoetes hewetti, Steb., in *Quercus incana*. Pairing-chambers and egg galleries in the outer sapwood. Government House, Naini Tal, N.W. Himalaya, May 1908.

commence to hatch out. The larva eats out a narrow tunnel in a direction at right angles from the egg-gallery, and this larval gallery appears to be invariably straight. This may be due to the hard straight fibres of the oak wood ; but, whatever the cause, this habit of the grub distinguishes it at once from other known Indian scolytid bark-boring grubs, whose tunnels invariably serpentine ; also, owing to the fact that the egg-galleries are at right angles to the long axis of the tree, i.e. go round the tree, the larval galleries go straight up and down the tree. The plan thus made is so different from any of the at present known Indian Scolytidae as to render the presence of this insect in the trees easily recognizable.

The larval galleries increase in diameter with the growth of the grub, but do not groove the sapwood as deeply as the egg-galleries.

The larva when full-grown eats out a depression in the sapwood at the end of its gallery and pupates. On maturing from the pupal stage the beetle eats its way through the bark which covers it, making a small circular exit-tunnel in it, and escapes to seek out a good tree in which to oviposit and carry on the attack. The presence of these numerous exit-holes on the outside of the bark serves as an indication that the beetles bred in it have left the tree.

The pupating-chamber is one-fifth by one-seventh of an inch in size ; the egg-gallery from one and a half to two inches in length, and the larval galleries from one and a quarter to two and a quarter inches ; the number of eggs laid is usually about twenty.

This insect is a polygamous one, and the male pairs with three or four females. In the case of the latter typically the egg-galleries of two of the females are taken in one direction and those of the other two in an opposite one, alternate beetles boring in opposite directions after pairing. A plan similar to that shown in pl. lii is thus obtained. Practically, however, it will be found that the direction of these egg-galleries varies, and they may curve considerably ; at times even it will be found that three take off on one side and one only on the other ; or again one or two may be extremely long and a third very short, the fourth being absent. These variations are doubtless due to differences in the physical capabilities of the beetles themselves and to variableness in the hardness of the wood, such as knots, etc. After pairing with the females the male dies in the pairing-chamber.

This beetle is an active little insect, leaving the trees in daylight, which is unusual with Scolytidae, and walking and flying actively about in the sunlight.

From observations made towards the end of May it is evident that a generation of the beetle was then just maturing and issuing from the trees. This generation of the beetles is probably the first generation of the year, and it is certainly followed by a second, since larvae from eggs laid by it were taken from the trees in June. It is probable that there is at least a third generation of beetles during the year, from eggs laid by the second generation, which probably issues in August. This point, how-

ever, requires further careful observations to be carried out between July and the close of the year. The eggs of the May generation of the beetle are probably laid in the trees early in April by beetles which have either passed through the winter in the tree or have hibernated as larvae in the larval galleries in the bast, subsequently maturing and issuing as beetles as soon as the first warmth of spring makes itself felt.

Damage Committed in the Forest.

At present I have only taken this insect in full-grown and old oak trees, but it apparently attacks both the moru and ban oaks. The danger to be feared from the insect is due to its habit of ovipositing in the bast layer of the trees. As has been shown, the operations of the beetles and their larvae lead to the destruction and disappearance of the bast, and when the insects are numerous end in the death of the tree. In several instances the death of large trees examined appeared to be due directly to the attacks of this insect.

Its greatest danger is, however, evidently to be found in the fact that it forms such a powerful ally to the *Loranthus vestitus* parasite which infests the oaks. Broad-leaved trees are much more resistant to the bark-boring beetle attacks than is the case with conifers, and consequently it is probable that the oak can ordinarily hold its own against the scolytid.

It is essential to the latter that the bast layer of the tree should be fresh and sappy; but the beetle invariably seeks out diseased trees, or those which have become weakened through some cause, in which to lay its eggs. The slow strangulation and consequent weakness set up in the trees by the *Loranthus* parasite places the tree in the exact condition preferred by bark beetles, and where these insects are at all numerous an attack in *Loranthus*-weakened trees may be looked upon as a foregone certainty. Once the insects have obtained a hold in a forest their powers of rapid multiplication render them a pest which has to be reckoned with.

Protection and Remedial Measures.

Protective and remedial measures for safeguarding the uninfested trees in Naini Tal and elsewhere have been briefly considered under the longicorn beetles *Lophosternus hügelii* and *Xylotrechus stebbingi* (pp. 275, 351). It will be well, however, to glance at measures applicable to this insect alone, since it is probable that very often it infests the tree before the buprestid or cerambycid pests make their appearance.

To combat these bark-borer pests adequately it becomes necessary to know the exact life history of the insect, and more especially in what months during the year it is in its larval stage, for it is in this stage that it can be best attacked. When the tree is full of nearly full-grown larvae, it should be felled and barked and the bark burnt. From the life history as at present observed we know that this can be done at the end of the first week in May for the grubs of the first generation and at about the end of June for those of the second generation.

Further, both as a means of discovering the number of insects in a forest and as a means of protecting that forest as well, "trap trees" should

be arranged for. Trees which are either sickly, already attacked, or are chosen for other reasons, should be selected and girdled or felled a week or so before the flight-time of the beetles. The insects will resort to these to oviposit, and when egg-laying has been completed and the trees are full of nearly full-grown larvae the bark should be stripped off and burnt.

Dryocoetes minor, Stebbing.

REFERENCES.—Stebbing (*Phloesinus*), Undescr. Scolyt. Ind. Regions, *Ind. For. Mem.* Zool. Ser. vol. i, pt. ii, 19 (1909); id. Assam Sál Ins. Pests, *For. Bull.* no. 11, 37 (1907).

Habitat.—Assam.

Tree Attacked.—Sál (*Shorea robusta*). Goalpara Sál Forests.

Description.

Beetle.—Short, compact, convex, dull brown, with a largely developed hood-like reddish-brown prothorax. Head small, dull brown, hidden beneath thorax, punctate. Prothorax convex, slightly wider than long, closely squamose behind, more open in front. Elytra black, convex, rounded, truncate behind; a little more than one and a half times as long as thorax; longitudinally striate-punctate, punctures few. Surface of elytra and thorax with scanty stiff yellowish hairs. Under-surface black, shining; legs brownish. Length, 3.9 mm. (Pl. lx, fig. 2.)

Life History.

This beetle is found on the wing in the middle and third week of May. The beetle bores straight down into the wood of newly felled green sál-trees (and probably into that of standing sickly ones) to oviposit. A beetle was cut out of a tree on the 16th, the tree, a green one, having been felled only three days before. The insect was engaged in eating out its egg-gallery. The presence of the insect can easily be recognized owing to the fact that little cylinders of ejected wood-dust are to be seen projecting from the entrance-holes in the bark. The colour of these, white or reddish, indicates whether the beetle is in the sap- or heart-wood. The beetles found in May were probably those of the first generation of the year just matured, and engaged in laying the eggs of the second generation.

Dryocoetes indicus, sp. nov., Stebbing.

Habitat.—North-West Himalaya.

Tree Attacked.—Spruce (*Picea morinda*). Jaunsar.

Description.

Beetle.—Oblong. Light to dark red or red-brown, with a rather long sparse pubescence. Head punctate, with a bright yellow brush of pubescence on the front. Prothorax slightly more than one-fourth the total length of insect, disk convex behind, sides uniformly curved from base to apex; surface scaly and rugose, the scales large and prominent on convex portion of disk, less well defined and wider apart on anterior parts and replaced by rugose punctures on depressed area posteriorly; pubescence long and rather scattered. Scutellum large, heart-shaped, smooth, shining, dark brown to black. Elytra broader apically than prothorax, apex rather sharply declivous, rounded; disk shining and strongly punctate, the punctures placed in rows, large, shallow, each having a small puncture at its bottom; the interspaces smaller, set with a row of

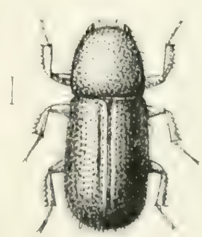


FIG. 352.

Dryocoetes indicus, sp. nov., Steb., in spruce. N.W. Himalaya.

very fine punctures ; declivity shining, the sutural striae most strongly impressed in upper part, the punctures smaller, becoming very fine and scattered apically ; pubescence long, spiny, denser on declivity. Under-surface dark brown, punctate. Legs red-brown, pubescent ; funiculus and club of antenna yellow. Length, 3.8 mm. to 4 mm.

Life History.

At the end of September 1906 I found a generation of this insect tunnelling into spruce saplings. Only beetles were present. The insect is polygamous, and in one case I took five beetles together. All the five were in an irregular-shaped depression in the cambium and sapwood in the main stem near its juncture with a branch. This cavity had the appearance of being a large pairing-chamber, from which arms (the egg-galleries) radiated as shown in fig. 353. Five of the arms were occupied by the beetles; the remaining two, the upper two on the left, being empty. I could find no eggs. A little higher up in the same tree two other beetles were tunnelling into the stem ; they had just reached the bast layer. The beetles were engaged in lengthening the galleries when discovered.

In the middle of the following November I revisited the infested trees, and found some more beetles in them. No further progress had, however, been made with the egg-galleries, none of which appeared to be complete. It appeared that the beetles were hibernating in the galleries till the following spring. As the elevation at which the insect was found was close on nine thousand feet, this is a probable assumption. I took one larva which may have hatched out from an egg laid by the beetles I took the previous September. The beetles taken in November were very lethargic.

Fig. 353.—*Dryocoetes indicus*, sp. nov. Pairing-chamber and egg-galleries on the inner surface of spruce bark. North-West Himalaya. (E. P. S.)

Relations to the Forest

This beetle infests young green spruce saplings. I first discovered the insect at work in a small clump of young green spruce on 28 September 1906. The tree most severely attacked had a considerable part of the bast layer riddled all round in several places, and was nearly dead. In November a further inspection showed another tree nearly dead (the needles were dropping off) and a third with the needles turning yellow. The insect consequently must be looked upon as a serious pest of young spruce.

As to its abundance I am unable to speak. I have only met with it on the two occasions mentioned.

Pityophthorus.

Pityophthorus sampsoni, Steb., sp. nov.

(*The Blue Pine Branch Girdler.*)

Habitat.—North-West Himalaya.

Tree Attacked.—Blue Pine (*Pinus excelsa*). Jaunsar, N.W. Himalaya.

Beetle.—Elongate, oblong. Very dark piceous brown. Head finely punctate and reticulate. Prothorax with base finely margined, truncate, sides behind very slightly oblique, rounded in front and sinuate below apex, latter obtusely rounded and scarcely crenate ; the surface in the anterior half with a number of asperations arranged transversely, most prominent anteriorly ; the posterior half rugose-punctate. Elytra slightly narrower at base than prothorax, wider apically, fully twice as long as prothorax, sides straight to apical fourth, thence constricted, apex obtusely rounded ; the basal area with transverse striae ; rest glabrous, punctate, the punctures in rows, interrupted by small transverse striae and rugosities ; the suture raised and glabrous ; declivity nearly vertical, moderately shining, punctate, with a few weak tubercles, the outer margins raised. Under-surface almost black, punctate, and strongly pubescent. Length, 1.7 mm.

Description.

I take pleasure in naming the species after Colonel F. Winn Sampson.

FIG. 354. *Pityophthorus sampsoni*, sp. nov., Stebbing, in blue pine. N.W Himalaya.

Life History.

This small scolytid infests the blue pine, attacking and girdling the smaller branches of the tree. I first discovered the insect in May 1902, between Deoban and Koti Kanesar in Jaunsar. I noticed that several blue-pine trees passed had a number of their smaller branches either dead or dying. Investigation showed that it was usually the secondary branches taking off from the main side branches that were affected in this manner. These branches were either upright, or in their normal position, on the tree, but with the needles dead and yellow or withering ; or in other cases the branches were hanging down as if half-broken from the tree. If these latter are pulled they will come away, and it can be seen that at the point of fracture the branch has been girdled, and a mass of exuded turpentine will usually be found at this point. This girdling is done by the female beetles, the eggs being laid in the branch above the point at which it is girdled. In this way a provision of slowly dying cambium is provided for the tiny larvae which hatch out of the eggs laid. Several larvae were taken in individual twigs, so that each beetle lays more than one egg in the twig she girdles. From some twigs I obtained beetles just mature on 22 May. In others full-grown larvae were present. The larvae feed entirely in the bast layer and outer sapwood, eating small wavy galleries up the girdled twig, and pupating at the end of them. When mature the beetle eats its way out through the bark covering the pupating-place of the grubs.

The beetle sometimes girdles the branch at its juncture with the main branch, at others chooses a point higher up. In any event the whole of

the branch or twig above the girdle dies, and in the damage it does the insect thus resembles the *Scolytus* deodar branch girdler (*vide* p. 578). The remedies to apply are the same as those described for the latter.

TOMICUS (IPS).

A very important genus, containing species infesting the blue pine, spruce, and *Pinus longifolia* in the Western Himalaya.

Tomicus (Ips) ribbentropi, Stebbing.

(*The Blue-Pine Tomicus Bark-borer.*)

REFERENCES.—Stebbing, *Ind. For. Mem.* Zool. Ser. i, pt. ii, 25; id. *Depart. Notes* (*Tomicus* sp.), i, 225; id. *For. Bull.* no. 5 (new ser.), 1911.

Habitat.—North-West Himalaya.

Trees Attacked.—Blue Pine (*Pinus excelsa*); Spruce (*Picea morinda*). Jaunsar, Tehri Garhwal, Kumaun, Kulu, Simla, Bashahr, Chamba.

Description.

Beetle.—♀ oblong, shining, black. Antennae and legs piceous brown. Head smooth, shining on vertex, with a few scattered fine punctures; front flat, roughly granulate-punctate, usually without tubercle, in some cases with a small median pit or depression, or with two very small tubercles placed transversely and medianly, the tubercles either minute and sharp, or merely slightly-raised rounded elevations; a few long yellow hairs on the lower lateral margin. Prothorax rounded in front, slightly wider behind than in front, one-fifth less wide than long; strongly rugose-punctate in anterior two-thirds; posterior third smooth and shining, with a few very scattered and fine punctures, or the punctures very fine but more numerous; rather densely set with long, stiff, yellow hairs anteriorly and laterally. Elytra slightly longer than thorax, striate-punctate, the punctures rather shallow, the interspaces broad and shining, the striae near the suture most prominent, finer towards the declivity. Truncate posteriorly, the declivous portion concave, dull, sometimes slightly shining and finely punctate towards bottom; the sides furnished with four teeth, of which 1 (upper one) is very small and set at a distance from 2; 2 close to 3, larger than 1; 3 largest, with a swollen head to it, the swelling not constant, as in some specimens 2 more nearly approximates in size to 3; 4 prominent and sharp, smaller than 3, and set farther from 3 than 3 is from 2 on the one side, and at a less distance from the lower margin; the declivity more abrupt than in *typographus* (fig. 355). Elytra laterally and edges of declivity fringed with long, yellow, spiny hairs. Under-surface black, but slightly shining, punctate, with a scattered longish yellow pubescence. ♂ smaller than ♀. Red-brown in colour and more pubescent. The prothorax is less convex medianly, more highly granulate anteriorly. Elytra with punctures more prominent, and apical declivity more sloping. Length, ♀ 5 mm. to 5.5 mm.; ♂ 4.5 mm. to 4.9 mm. (Pl. xlvi, fig. 3, *c*, *d*). The absence of the prominent tubercle on the front, and the different nature of the teeth on the elytral declivity and its more abrupt slope in ♀, sufficiently distinguish this species from *typographus* of Europe.

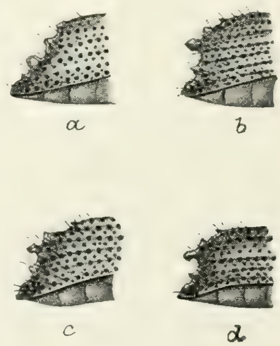


FIG. 355. — Elytral declivity of *Tomicus*. a, *Tomicus typographus*, Linn.; b, *T. ribbentropi*, Steb.; c, *T. longifolia*, Steb.; d, *T. blandfordi*, Steb.

Larva.—A small, thick, curved, legless, white grub with a yellow head, and the body segments corrugated; the segments following the head are the largest, the body tapering (fig. 3, *a*).

Pupa.—The pupa is white in colour and has the general shape of the beetle, but with the antennae and legs pressed to the sides and the wings pressed against the chest (fig. 3 *b*.)

Tomicus ribbentropi, Steb., in spruce. The pairing chambers, egg-galleries, and larval galleries are shown in the bast layer of the tree (on the inner bark). Many of the larval galleries contain living larvae, some of which were commencing to pupate when the drawing was made. Chamba, North-West Himalaya. M. E. Stebbing *del. et pinx.* [illegible].

Life History. The first beetles of the year are found towards the end of April boring into the trunks of blue pine (*Pinus excelsa*) or spruce (*Picea morinda*) of all ages, from the pole stage upwards. When it has reached the bast the insect gnaws out an irregular-shaped pairing-chamber, often as much as ½ in. by ¼ in. in size (see pl. liii; pl. liv, *p*.) When this is ready coupling takes place, several female beetles entering by the same tunnel and being fertilized by the male. From two to four egg-galleries (the number is usually three) are excavated, grooving both bark and sapwood, radiating from the pairing-chamber (pl. liii; pl. liv, *e*), and more or less in the long axis of the tree. These galleries, which contain generally only one air-hole (pl. liv, *a*), i.e. a hole bored horizontally through the bark to the outside to admit air into the egg-gallery, are from two and a half to three inches in length, and are bored by the female beetles. On the right and left, but apparently chiefly on the right, she eats out little recesses, laying in each an egg, from twenty to thirty being generally deposited in each gallery. The galleries are blocked up with wood-dust. As only one egg-gallery is bored by each female, it would appear that the beetle pairs with two to four females.

The first larvae make their appearance before the egg-laying is over, and at once commence to eat out winding galleries in the bast, which have a general direction at right angles to the direction of the mother-gallery. The greater number of the larvae appear to develop from the eggs laid on the right hand of the gallery (see pl. liii; pl. liv, *l*), as the mother bores away from the pairing-chamber, so that the larval tunnels shall keep clear of the neighbouring egg-gallery. As the larvae increase in size so does the diameter of the tunnels they are boring; they go deeper into the bark, and the whole plan of the mother and larval galleries remains indelibly impressed on the bark long after the beetles have matured and left the tree. The larval borings only slightly groove the sapwood, consequently this latter only bears the impression of the pairing-chamber and the egg-galleries with the notches cut by the beetles for the reception of their eggs (see pl. xl). In the case of an old attack, therefore, if one wishes to find out whether the eggs hatched out and the larvae became full-grown, it is necessary to inspect the bark on the inside in addition to the sapwood.

The mother galleries are often as much as three inches in length, and those of the larvae, which are usually very winding, one and a half to two and a half inches. The larvae pupate at the end of their galleries in the bast during the first days in June. Towards the middle of the month the new beetles, now mature, leave the tree through round holes bored horizontally through the bark from the pupating-chamber, and immediately attack fresh trees and lay their eggs in them. The larvae from these eggs soon make their appearance, and the resulting beetles issue about the beginning of August. A third generation of beetles appears in the first half of October, and from eggs laid by these the larvae of a fourth during October–

November. In favourable years some of these latter develop into beetles, which pass through the winter either in the pupal chamber, or, not improbably if fully mature, in the thick bark of the trees. The remainder of the larvae pass the winter at the end of their galleries, in which they gnaw out a small chamber and then envelop themselves in a thin, papery cocoon. Those which, as above described, go on to the beetle stage, are the beetles of the fourth generation, and are the ones which appear in the spring (April) and lay the eggs of the first generation of the year. The hibernating larvae change early in the year into pupae, and these into beetles, the latter appearing also about the beginning of May, and this leads to the generations overlapping to some extent.

It is probable that when the circumstances of its environment are unfavourable, such as damp, very cold weather, shady places at high elevations, etc., the normal number of generations passed through during the year is three. Similarly in very favourable situations, and in warm, dry years, it is not improbable that the insect will be found to pass through four complete life-cycles.

The time when these various generations may be expected to appear in the forest is therefore somewhat as follows :—

GENERATION I.	
End of April	Eggs
1st week in May to 1st week in June	Grubs
1st week in June to 3rd week in June	Nymphs
2nd week in June to end of June	Beetles
GENERATION II.	
3rd week in June	Eggs
4th week in June to 4th week in July	Grubs
4th week in July to middle of August	Nymphs
1st week in August to 3rd week in August	Beetles
GENERATION III.	
2nd week in August	Eggs
3rd week in August to 3rd week in September	Grubs
3rd week in September to 1st week in October	Nymphs
End of September to middle of October	Beetles
GENERATION IV.	
1st week in October	Eggs
2nd week in October to 2nd week in November	Grubs
(Some of these will hibernate and pass the winter as grubs.)	
2nd week in November to end of November	Nymphs
3rd week in November to beginning of following May	Beetles

Damage Committed in the Forest.

This insect, both in the larval and beetle state, does serious injury to the blue pine and the spruce (*Picea morinda*). The *Tomicus* is not usually to be found in young poles, though it may attack them near the base, and it does not attack young growth. In older poles it is often present, but it

nat size.

GALLERIES OF THE BLUE PINE TOMICUS, *TOMICUS RIBBENTROPI*, STEB

apparently prefers the older trees whose bark is thicker; when attacking poles, it confines its operations more especially to the lower three-quarters of the bole, leaving the upper quarter and the branches to its companions, *Polygraphus major* (p. 501) and *Pityogenes coniferae* (p. 562).

The injuries to the tree are confined to the bast layer, and when it is badly infested this part of the tree is completely riddled and destroyed, resulting in death. Attacked trees can be recognized by the shot-hole borings in the bark, each having a little sawdust at its entrance which has been ejected by the beetles when making the burrow. If trees with large numbers of these holes on their outer bark be cut into, the cambium layer will be found to be swarming with either larvae, pupae, or beetles.

Sickly trees, ringed trees, and newly felled ones are at once attacked by it, and its powers of rapid multiplication—which have been shown to be very great, owing to the number of eggs laid by the beetle and the number of generations it is capable of passing through during the year—enable it to spread rapidly over large areas. When particularly abundant in a locality I have found it attacking green healthy trees. It does not attack barked trees, and it has not been found in stools or stumps.

Ringing trees to allow them slowly to die is a sure method of increasing the numbers of this insect in a forest, since the beetles will resort to these trees, which are in the exact condition they prefer for egg-laying. Also heavy fellings, when the bark is left on the trees from two to three months after the trees have been felled, are favourable to an increase in the numbers of this beetle. Wind- and snow-breaks are similarly taken advantage of if left unbarked in the forest.

The *Tomicus* insect must be looked upon as all the more dangerous owing to the fact that it attacks equally the blue pine and spruce.

The probable working in the near future of areas containing these species on a far larger scale than has been the case makes it imperative that a first-hand knowledge of this beetle's life history and capabilities for damage in the forest should be possessed by the Forest Officer in charge of such work.

Protection and Remedies.

These are very similar to those given in detail for the deodar bark-borer on p. 572. Stress must be laid, however, on the great usefulness of "trap" trees. By felling a few of these at intervals through the year (middle of April to end of November), and keeping them under supervision, it is quite possible for the Range Officer to keep himself fully acquainted with the abundance of bark beetles in his forests, and in the event of the insects suddenly beginning to increase in unusual numbers it will place him in a position to give early intimation and warning of this fact to his Divisional Officer.

The girdling of blue pine and spruce to encourage the regeneration of deodar, if carried out, should be done in such a manner that the girdled trees

are made use of as "trap" trees and removed in due time, when the trees are full of mature grubs. Allowing girdled green trees to remain standing in the forest is sure to lead to a bad infestation of this pest.

Parasitic and Predaceous Insects.

Pompilus sp.—The grub of this fly feeds parasitically upon the *Tomicus* larvae.

Fly.—The fly is black in colour, but I have not succeeded in obtaining any fully mature insects. Mr. Claude Morley identifies the insect as a species of *Pompilus.*

Grub.—Yellow in colour, pointed at each end, legless, with a small head and segmented body.

Life History.—I have taken this insect on several occasions in Jaunsar (in 1902 and 1906), but usually in the larval or pupal stage. It should prove comparatively easy to rear the flies, but I have been unfortunate in my attempts.

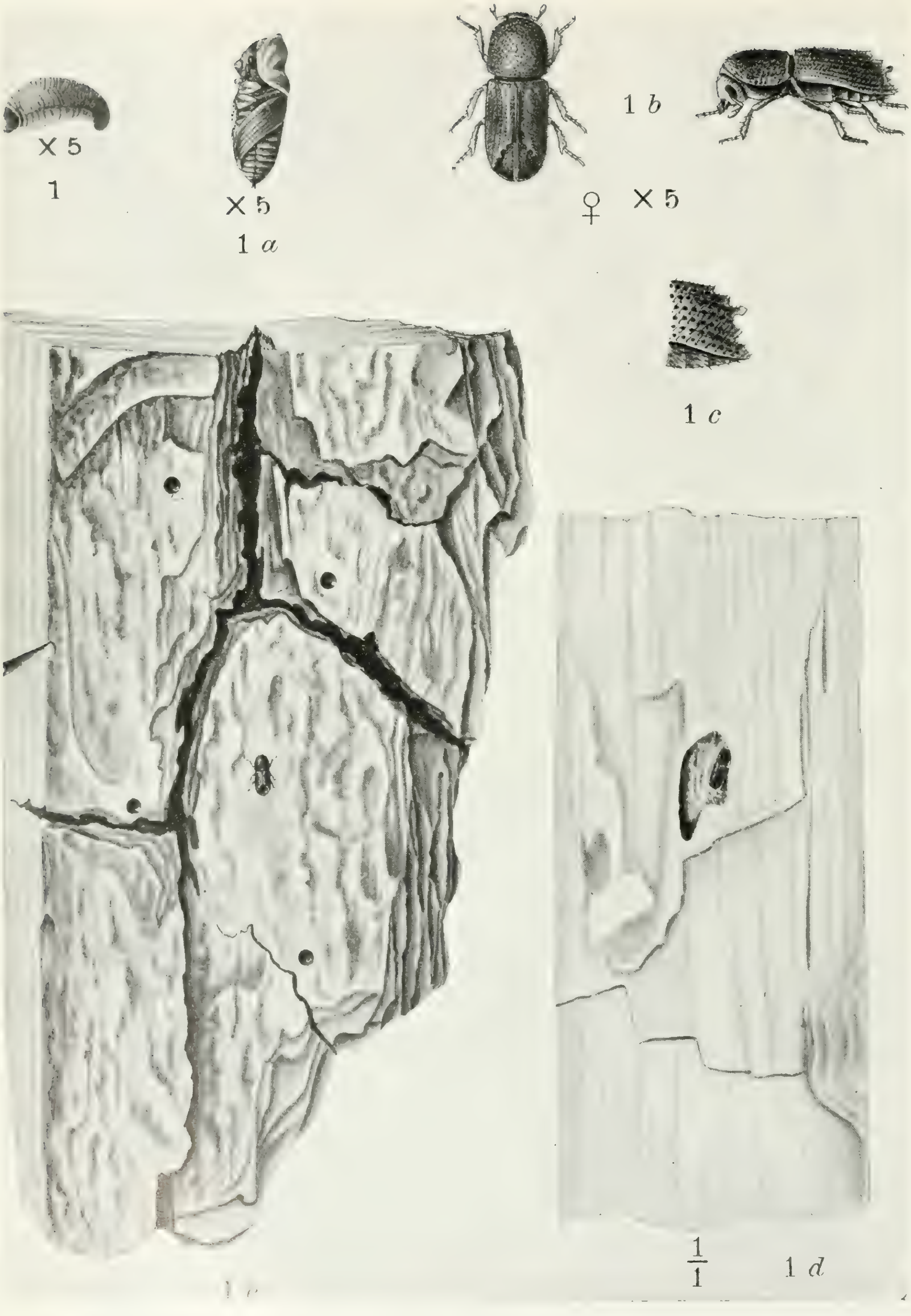
The life history is simple. The fly evidently creeps down the entrance-tunnel of the *Tomicus* beetle and lays her egg or eggs in the pairing-chamber or egg-galleries. The grub on hatching out crawls down the short gallery in the bast of the young scolytid larva and attaches itself to the latter. It then feeds parasitically on its host, but does not kill it until the *Tomicus* grub has reached full size and completed its larval gallery and eaten out the pupal chamber at the end. The latter then dies of exhaustion, the greyish black shrivelled skin being visible in the pupal chamber. By the time the scolytid larva dies the parasitic grub has reached full size and pupates in the pupal chamber made by its host. The flies mature about the time the next generation of the *Tomicus* is egg-laying, and they then leave the tree and oviposit in the egg-galleries of this generation of their host. Observation would seem to show that the number of generations in the year of the parasite coincides with those of its host.

The *Pompilus* must be looked upon as a most important insect in the forest.

Cylistosoma dufali, Mars. (p. 106).—This insect is predaceous upon this *Tomicus* and also, doubtfully, on *Polygraphus pini.*

Beetle.—Elongate, narrow, compact, black, and shining. The head is provided with stout mandibles and angled brownish antennae ending in a club. Thorax wider than long, smooth and shining. Elytra elongate, smooth and shining in centre, with several well-marked longitudinal striae laterally; the elytra leave the last two segments of the body exposed, these segments being heavily punctured. Under-surface of body and legs brownish. Length, $\frac{5}{32}$ in.

Life History.—This insect is to be found fairly commonly in the beetle stage at the end of May at elevations of about 7,500 ft. in the coniferous areas of the North-West Himalaya. It frequents the galleries of the blue-pine and spruce *Tomicus,* and apparently oviposits in them. The histerid



Tomicus longifolia, Steb., in *Pinus longifolia*.—1, 1*a*, larva and pupa; 1*b*, female beetle; 1*c*, side view of elytral declivity; 1*d*, pairing-chamber being eaten out in the sapwood by the male beetle; 1*e*, entrance-holes of beetles on the outer bark of the tree, with a female beetle commencing to bore into the bark. Jaunsar, North-West Himalaya.

grubs, I believe, feed upon those of the *Tomicus*, but further observation is required to definitely settle this point.

Platysoma rimae ? Lewis (p. 105).—This histerid is also predaceous upon the *Tomicus* insect, and is found in its galleries. This *Platysoma* may be identical with the one infesting the *Scolytus* of the deodar (p. 576), but I am doubtful on this point.

Both **Niponius canalicollis** and **Thanasimus himalayensis**, the two predaceous beetles already described as feeding upon the *Polygraphus major* beetle (p. 507), prey upon the *Tomicus ribbentropi* insect in a similar manner, whilst their larvae feed upon the bark-borer grubs in the tunnels in a similar fashion.

FIG. 356. — *Platysoma rimae* ? Lewis, predaceous on *Tomicus ribbentropi* in blue pine. ×6. N.W. Himalaya.

Tomicus (Ips) longifolia, Stebbing.

(The Long-needled Pine Tomicus.)

REFERENCES.—Stebbing, *Ind. For. Mem.* Zool. Ser. i, pt. ii, 13; id. *Depart. Notes*, i. 282.

Habitat.—Probably distributed throughout the *Pinus longifolia* forests of the North-West Himalaya. I have taken it in Jaunsar, Tehri Garhwal, Kumaun, and Chamba.

Tree Attacked.—Chir Pine (*Pinus longifolia*).

Description.

Beetle.—Smaller than *T. ribbentropi*. Very dark ferrugineous brown, with longish rufous brown hairs scattered irregularly over thorax and elytra. Head smooth, moderately shining, finely punctate, three prominent tubercles on each side of face. Anterior half of prothorax strongly rugose-punctate, basal half smooth and shining medianly, punctate laterally; sides clothed with stiff yellow hairs. Elytra smooth, shining, striate-punctate, the punctures large and evenly arranged in parallel rows; lateral margins of declivity armed with four teeth—1 small, sharp, and prominent, and set at a distance from 2; 2 and 3 placed close together on a bulging prominence of the margin of nearly equal size, save that 3 has its apex enlarged into a spade-like club with a constriction at its base; 4 smaller than 2 and 3, and set midway between 3 and the lower margin. (*Vide* pl. lv, fig. 1 *c*.) Elytra clothed with stout spiny yellow hairs. Undersurface smooth, shining, punctate, fairly thickly clothed with long yellow hairs, save on the metathorax medianly. Fig. 1 *b* shows a dorsal and side view of the female beetle. ♂ smaller than the female, yellowish brown. The rugosities on the thorax are finer. Length, ♀ one-fifth inch, ♂ one-sixth inch. Easily distinguishable from the blue-pine *Tomicus*, by its smaller size, difference in the apical teeth, and different appearance of front of head.

Larva.—Whitish yellow, curved, corrugated, and legless. Head well developed, yellow, shining; first prothoracic segment with a dorsal horny plate to it. Length, a quarter of an inch (pl. lv, fig. 1).

Pupa.—Yellowish white, large and thick. The prothorax shows a well-marked horny shield on the dorsal surface. The wings are bent on to the breast beneath, as also the legs and antennae. Length, about a quarter of an inch. (Fig. 1 *a*).

Life History.

The life history of this *Tomicus* resembles to some extent that of *T. ribbentropi*, Stebbing, of the blue pine and spruce, but varies in a few important particulars. In attacking the tree the male beetle bores through the thick bark down to the bast, and eats out in the sapwood a squarish pairing-chamber about half an inch by just under half an inch. Fig. 1 *d* in the plate shows a male beetle in the pairing-chamber. A female enters by the same hole, and after pairing bores away from the pairing-chamber in an upward direction parallel to the long axis of the tree. A second, third, and fourth follow, the third going in the same direction as the first, the second and fourth in an opposite one. The egg-galleries so eaten out are very long, often as much as three to five inches, or even more, in length. The female, as she eats out her egg-gallery, carries one or more, normally two, aeration tunnels to the outside; these air-holes do not pierce the bark entirely, a thin lamella of outside bark being left for protective purposes to prevent the ingress of outside intruders, chiefly enemies, into the tunnel.

The female egg-tunnel is always kept entirely free from sawdust, excreta, and other wood particles. It grooves deeply the sapwood, and is usually slightly serpentine in character. The eggs, some forty to sixty in number, are laid in notches eaten in the side walls of the gallery, the larger number being usually laid on the wall remote from the adjacent egg-gallery of the other female. On hatching out from the egg the larvae eat out galleries which are very winding and appear to have no definite direction, often being inclined at an acute angle to the egg-gallery, and occasionally curving back upon themselves as the grub approaches full growth; the grub thus eats out a much larger gallery than is required for its breadth. This larval gallery chiefly grooves the inner bark, and is tightly packed with wood excreta (pl. lvi). When the insect has attacked a tree in numbers, the long main egg-galleries and a mass of intersecting larval galleries tightly packed with wood excreta almost entirely remove the bast layer. When full-grown the larva enlarges the end of its gallery in the inner bark into a squarish irregular pupal chamber and pupates in this; this pupal chamber is the only portion of the larval gallery which is free from wood-dust and excreta. On maturing the beetle bores straight through the bark to the outside of the tree and escapes. Observation would seem to show that the beetles mostly mature and leave the tree in swarms at about the same time. For instance, in some green trees blown down during the rains of 1906 (probably towards the end of August), and examined in the middle of October 1906, the insect was found in the immature, or nearly mature, beetle stage, in the upper parts of the main stem of the tree, whilst in the thick lower parts of trunk and butt where the bark was still green and fresh the newly issued beetles were tunnelling in to lay the eggs of the last generation or partial generation of the year. No pupae were found in these trees, and only a few belated grubs. Fig. 1 *e* in pl. lv shows several of these entrance-holes on the outer bark, and a beetle just commencing to burrow into the tree.

PLATE LVI.

Part of a stem of a *Pinus longifolia* showing the pairing-chambers, egg-galleries, and larval galleries of *Tomicus longifolia*, Steb., on the sapwood. North-West Himalaya.

From observations made in October and November 1906 in Jaunsar and Tehri Garhwal, and others undertaken in May and June in both Jaunsar and Kumaun, it would appear that the insect commences to lay the eggs of the first generation of the year some time early in April (or perhaps towards the end of March), the beetles hatching out from these eggs appearing towards the end of May, a couple of days being passed in the egg stage, some five to six weeks in the larval, and ten days to a fortnight in the pupal condition. Allowing from six weeks to two months to a generation, a second generation of the beetles would issue towards the end of July, and a third towards the end of September, which would lay the eggs of a fourth generation, which may either hibernate as larvae in the trees or go on to the mature stage and pass through the winter as beetles. In favourable years this fourth generation may be completed, and may lay the eggs of a partial fifth generation. For instance, on 11 October, at a fairly high elevation in Jaunsar, I found the beetles of the third generation issuing and egg-laying, or nearly mature. On 3 November, at a much lower elevation, in the Tons Valley in Jaunsar (at Thadiar), I found the beetles of the fourth generation maturing. These beetles were issuing to deposit in the trees the eggs of the fifth generation of the year.

I first noticed old traces of the attacks of this insect in June 1902 in the Tons Valley, Jaunsar, and found one dead beetle. In October 1906 I took the insect numerously at Jermola and elsewhere in Jaunsar and Tehri Garhwal, and in May and June 1908 I took the insect in the Kumaun *P. longifolia* forests. In June 1909 I found the beetle in chir-trees in the Ravi Valley in Chamba.

Damage Committed in the Forest.

As far as present observations show, this *Tomicus* only infests the *Pinus longifolia* in the pole and older-growth stages. I have not taken the insect in seedlings or saplings, nor in the thinner branches of the crowns of the larger trees. The insect must be classed as one of the more dangerous of the pests of the tree. It only infests green trees, either newly felled or blown-down ones, or sickly standing ones in the forest. I have taken it attacking green trees in company with *Cryptorhynchus brandisi* and *Polygraphus longifolia*. Its presence when in any numbers can easily be detected from the outside, owing to the fact that it ejects from the entrance-hole small cylinders or heaps of light red and yellow sawdust, these little heaps being distinctly visible on the rough red bark of the tree. Once the insect has infested a tree in any numbers, the death of the tree is a certainty. Owing to the long egg and larval galleries eaten out, and the winding manner in which the latter are taken, little of the inner bast layer of the tree is left intact, the untouched portions consisting merely of small ridges and rims of bast between the mass of excreta-filled galleries.

The attacks of such an insect are naturally the more to be feared in a pure than in a mixed forest.

Protection and Remedial Measures.

I need scarcely add anything here to the remarks made under *Cryptorhynchus* (p. 433) and *Polygraphus* (p. 506). In the case of this insect, however, it is most important that the bark should be stripped from the trees as soon as possible after the latter have been felled. To leave them lying in the forest for several months after felling means that one, or perhaps two, complete generations of this pest may be bred out of the trees, this meaning half a million or more beetles issuing from each tree to carry on the infection in the forest.

To ascertain the abundance of the beetle in any forest, it might be advisable each spring to fell a green tree or two and visit it some time early in May. By stripping off a foot or two of the bark it will be possible to ascertain to what extent it has been attacked by the insect. This would enable the Range Officer to obtain a very fair idea of the damage he may expect to occur from this pest.

Parasitic and Predaceous Insects.

Chalcid sp.—The grub of this small fly feeds parasitically upon the larva of *Tomicus longifolia*, and perhaps on that of *Polygraphus longifolia*. I took specimens in Jaunsar in the North-West Himalaya.

Fly.—A minute black-coloured four-winged fly.

Cocoon.—Oval, elliptical, small, flat, and of a papery consistence.

Life History.—I know little of this insect at present. I found it maturing in the upper part of a large *P. longifolia* tree in which a number of *Tomicus longifolia* beetles were nearly mature. Some of these latter beetles had already left the tree, as also had some of the Ichneumon flies. I found them hovering over the lower butt of the tree into which the *Tomicus* beetles were tunnelling to lay their eggs, or crawling down the tunnels, presumably to oviposit. The fly is very active on the wing in broad sunlight, and is difficult to catch. I took some specimens in the *Tomicus* galleries. The larva spins a small, flat, oval, elliptical, papery cocoon in which it pupates. The grub probably feeds parasitically on the *Tomicus* grub.

Niponius canalicollis, Lewis.—The grub of this insect is parasitic on that of *Tomicus longifolia* and *Polygraphus longifolia*. This insect has been already fully described on p. 507. I took specimens of the mature beetle in *Pinus longifolia*, in company with both the above bark-borers, on several occasions in the Naini Tal forests in June 1908. The insect is very plentiful in the coniferous forests of the North-West Himalaya.

Paromalus sp. (p. 107).—The grubs feed parasitically on those of *Tomicus longifolia* and *Polygraphus longifolia*. I took specimens of this insect in Jaunsar, in the North-West Himalaya.

Beetle.—Oval, square, very hard and compact, flat. Black, shining; the elytra leave exposed the posterior two segments of the body.

Life History.—The beetle was taken in numbers in a large standing green tree which was being badly attacked by *Tomicus longifolia* and *Poly-*

graphus longifolia in the middle of October. The beetles were evidently engaged in egg-laying, and the grubs probably feed on those of the *Tomicus* and *Polygraphus* beetles. I had already taken what I think is the same beetle in a newly dead tree a week previously. I think these latter beetles were just maturing, their grubs having fed upon those of the *Tomicus* and *Polygraphus* beetles. The stem and bark were covered with the egg and larval galleries of these two beetles, but the generations had matured and left the tree. These genera of histerid beetles are undoubtedly of great importance in the forest.

Tachyta nietneri, Schaum.—The larva is probably predaceous upon the *Tomicus* grubs (p. 96).

Timnochila coerulea, Oliv., var.—This large, elongate, blue-black trogositid is predaceous upon the *Tomicus* and also upon *Polygraphus longifolia*. The beetle is figured on p. 115.

Thanasimus himalayensis, Steb.—This clerid beetle feeds upon the *Tomicus* beetles. It is described on p. 508.

Tomicus (Ips) sp.

REFERENCE.—Stebbing, The Chilgoza Forests of Zhob and the Takht-i-Suliman, *For. Bull.* no. 7, p. 27 (1906).

Habitat.—Takht-i-Suliman, North Zhob, Baluchistan.

Tree Attacked.—Blue Pine (*Pinus excelsa*). Takht-i-Suliman.

Beetle.—Smaller than *ribbentropi*. Has a general resemblance to it. The specimens taken were in too poor a state of preservation to make description possible.

Life History.

I took a few dead individuals of this beetle from a large wind-blown blue pine in the Torgai nala at the lower part of the Maidan on the Takht-i-Suliman range of the Suliman Mountains in North Zhob in November 1905. I saw other evidences of the work of this insect in blue-pine trees in this locality. There was no forest conservancy in this part of the country at that time, and a large tree was felled even if it was only desired to fashion a rude wooden door from one of the logs by the crude, wasteful, and lengthy method of chipping off the wood till the desired size and thickness is attained. The life history of the insect would seem to resemble that of *T. ribbentropi*. Three females appear ordinarily to pair with the male, the egg-galleries grooving both bast and sapwood, the larval galleries being made in the bast only. This is all that is at present known of this insect.

Tomicus (Ips) blandfordi, Stebbing.

REFERENCE.—Stebbing, *Ind. For. Mem.* Zool. Ser. vol. i, pt. ii, 27.

Habitat.—Zhob, Baluchistan, Suliman Mountains.

Tree Attacked.—Chilgoza Pine (*Pinus gerardiana*). Shinghar, Zhob.

Description.

Beetle.—Oblong, shining. Head and prothorax black; elytra rufous brown. Head uniformly rugose-punctate on front, with two small tubercles placed close together transversely just below the middle and on each side of a short, narrow, longitudinal depression; a thick fringe of yellow hairs above and below the mouth, and clothing more sparsely the front. Vertex striate with largish shallow confluent punctures, which become finer and more numerous on the sides. Prothorax

widest in front, convex, most convex medianly; one-fourth less wide than long; coarsely rugose-punctate on anterior half, the rugosities transversely and acutely lozenge-shaped medianly and being replaced by finer punctures on the lateral edges. Posterior half smooth and shining medianly, with fine scattered punctures which are closer and thicker on sides. Densely set with fine yellow hairs laterally. Elytra red-brown, shining, striate-punctate, the punctures large and shallow, becoming confluent medianly just above the declivity, smaller and less well marked laterally; interspaces broad, smooth, but feebly convex, shining, set with scattered hairs, thicker laterally. Declivity deeply concave, slightly shining, punctate, with a fringe of stiff yellow hairs bordering the suture and an edging of long and short yellow hairs encircling the declivous portion. The teeth are four in number; 1 is very small and far removed from 2 and 3, which are close together and of nearly equal size save that 3 is slightly knobbed, the knob depressed; 4 is quite close to the lower margin instead of being equidistant from 3 and the lower margin as in *longifolia* (fig. 355, *d*). Under-surface shining, finely punctate, clothed with long whitish-yellow hairs. The front coxae large, globose, and placed close together. Length, 4.75 mm.

The difference in the size and position of the apical teeth is sufficient to distinguish this species from *ribbentropi* and *longifolia*.

Little is known about the life history of this species. It was taken from beneath the bark of dying chilgoza-trees at Shinghar in July by Captain James, I.A., Political Agent, Zhob.

Tomicus (Ips) stebbingi, Strohm.

Reference.—Strohmeyer, *Entomol. Wochenbl.* xxv, p. 69, 1908.

Habitat.—North-West Himalaya.

Tree Attacked.—Deodar (*Cedrus deodara*). Kulu.

Life History. Strohmeyer received four males of this insect from C. Rost from Kulu, said to have been taken from deodar. I have never found a *Tomicus* of the size of Strohmeyer's insects in the deodar in the Western Himalaya, and without seeing his specimens am unable to distinguish the species from *Tomicus ribbentropi*.

Pityogenes.

Hagedorn includes this genus under *Tomicus* (*Ips*). I have preferred to keep it distinct.

Pityogenes coniferae, Stebbing.

References.—Stebbing, *Ind. For. Mem.* Zool. Ser. vol. i, pt. i, 30; id. Chilgoza Bark-Bor. Zhob. *For. Bull.* no. 3, p 14; *Depart. Notes*, i, p. 242.

Habitat.—N.W. Himalaya; N. Zhob, Baluchistan (Suliman Mountains).

Trees Attacked.—Deodar (*Cedrus deodara*); Blue Pine (*Pinus excelsa*); Spruce (*Picea morinda*). N.W. Himalaya; Chilgoza Pine (*Pinus gerardiana*), N. Zhob, and Suliman Mountains.

Beetle.—♀ Sub-elongate. Black, shining; the elytra often orange or red-brown with black basal and lateral edging. **Description.** Head black, with a strongly marked deep square depression on upper part of forehead and two small posterior ones on either side of a post-median raised space which is moderately shining and finely punctate. Thorax constricted and rounded anteriorly; rugose-punctate, rugosities strongest in the anterior half and increasing in size to a raised central

point ; from the latter a median narrow longitudinal smooth shining space runs to base ; the rugosities and punctures finer on either side of this smooth space than in the anterior half. Elytra shining orange-brown ; base, basal half of suture, and lateral edges black ; rather flat, the punctures fine and not very close together ; the apical depression set with three longitudinally placed blunt teeth, the upper ones nearer suture than the outer margin ; upper one small and inconspicuous, the next but slightly larger, the apical one more prominent, pointed, and placed medianly. Under-surface with scattered yellowish pubescence ; antennae and legs rufous brown. Length, 2.75 mm. ♂. The front of head is smooth, flat, without depressions, with a transverse raised ridge, thickest medianly, on posterior margin ; punctures slightly rugose. Thorax slightly shorter and broader than in the female, the rugosities slightly stronger anteriorly and the punctures finer in the basal half. Elytra dark red-brown or black, more shining and more convex than in ♀, the punctures finer and rather scattered, the apical depression longer and less vertical and deeper than in ♀ ; the three longitudinally placed teeth much longer and sharper, the uppermost smallest, turned inwards ; the median one longest, set upwards and inwards ; the apical one sharp, curved inwards, smaller than the median one. Length, 2 mm. The size of both males and females varies to a slight extent (pl. xlviii, figs. 3, 3 *c*).

Larva.—A minute, curved, rather corrugated, white, legless grub with a canary-yellow head.

Pupa.—White, having the shape of the beetle.

Life History.

This *Pitoygenes* commences to lay the first generation of eggs of the year in April. The beetles are not particular as to the part of the bark of the tree they bore in through, and appear to bore through an exposed flake of outer bark as often as they seek a crevice to shelter themselves whilst at work. Doubtless numbers are seized and consumed by such enemies as the *Thanasimus* beetle and others whilst they are at work in the first stages of tunnelling into the tree. The male bores the first tunnel down to the sapwood and eats out in this a pairing-chamber. He is aided in the latter part of the work of constructing this chamber by one or more of the females which enter to him, the pairing-chamber being finally as much as 3 mm. across (cf. fig. 358). The first female to enter to the male does so by enlarging the tunnel of the male, since the female is of larger size. The females subsequently entering either do so by the original tunnel of the male or eat out separate tunnels of their own which hit off the lower part of the male's entrance-tunnel or the pairing-chamber direct.

Fig. 357. *Pityogenes coniferae*, Steb. *a*, larva ; *b*, pupa. N.W. Himalaya.

As many as five females (and occasionally six) enter and pair with one male. Each female in turn as soon as fertilized bores away from the pairing-chamber, eating out a gallery which curves in one direction only, from right to left. Each of the five female galleries, which may be as much as 13 mm. long, is started in a different direction, so that when all the galleries are finished the whole thing has a stellate appearance (cf. fig. 358). Whilst making her egg-gallery the female eats out small notches or depressions in the margin, mostly on the outside of the curve, and places an egg in each. About ten to twelve eggs are laid in each gallery, this

being apparently the number laid per female beetle. The larvae on hatching out bore away from the mother gallery, their galleries curving in an irregular manner and being from 10 mm. to 20 mm. in length. They feed chiefly in the bast layer, so that their galleries do not groove the sapwood. When full-fed the larvae eat out a depression at the end of their gallery in the sapwood and pupate in this. Fig. 358 shows pairing-chambers, egg-galleries, and pupating-chambers in the sapwood of a deodar branch.

The beetles when mature tunnel through the bark above them and escape from the tree.

The insect passes through four generations in the year and a partial fifth. The eggs of the first generation are laid, as I have said, in April, the beetles from these eggs appearing early in June. From the eggs laid by them a second generation of beetles appears at the end of July, a third in September, and the fourth towards the end of October or beginning of November. These beetles lay eggs which produce the larvae which pass through the winter in this stage in the trees.

Damage Committed in the Forest.

The presence of this beetle in a forest can easily be recognized in the smaller dead branches and twigs littering the ground. If these latter are examined they will be found to be covered with sharply cut definite patterns (I am alluding to branches from which the bark has fallen off). If these markings are examined they will be seen to consist of from four to six arms or galleries radiating from a common central depression ; each gallery curves away from the central chamber, and is marked on one side with little recesses arranged in a regular, systematic manner. The central depression is the pairing-chamber, each of the radiating arms an egg-gallery made by a female, and the little recesses, which are from six to nine in number and made on one side of the gallery only, formerly each contained an egg. If the bark of this twig could be examined on the inner side it would show the larval galleries giving off more or less at right angles to the egg-gallery, one starting from each of the nicks and winding round the twig. At

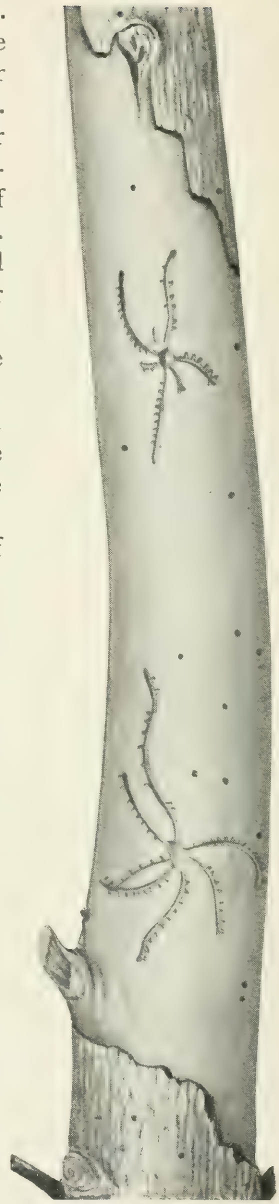


FIG. 358. — Part of a deodar branch showing the central pairing-chamber made by the male beetle of *Pityogenes coniferae*, and the star-shaped egg-galleries with notches on their sides made by the female beetles. N.W. Himalaya.

the end of the larval gallery a little enlargement is made, and the larva changes into a pupa in this, the latter turning in due course into a beetle and boring its way out of the branch.

This little beetle confines its operations to the smaller branches of the coniferous tree attacked, where the bark is still quite soft. It infests these places in enormous numbers, working in company with the larger *Polygraphus* (*P. major*, p. 501). It is to be found in the side branches and upper portion of the leading shoot of older saplings. In smaller ones it infests every part, and it then becomes a serious pest, as it would appear to have the power of increasing in large numbers. Its attack can be recognized from the outside by the small pin-holes seen in the bark, each surrounded with a small white ring of resin; the bark when very young turns yellow under the attack and shrivels up. The arms of the stellate galleries run longitudinally up and down the stem rather than horizontally, and the plans of the pairing-chamber and egg-galleries are not unlike those of *P. major*, with which they are often found mixed up and interlaced. The latter are, however, larger, have longer arms, and the egg-galleries are fewer in number and go much deeper into the sapwood, this being more especially noticeable in the case of the smaller branches attacked.

I have found this *Pityogenes* in company with *Polygraphus major* infesting deodar saplings. It was very numerous in the tops of saplings at Pajidhar in Jaunsar in June 1902. In a few cases it was found in the main stem, low down, and the gallery had then only four arms or egg-galleries to it, the pairing-chamber being made entirely in the bast, as also were the larval galleries and pupating-chamber, only the egg-galleries grooving down into the sapwood. In the tops, however, and leading shoots the attack corresponded in all respects to that in the blue pine. I was unable to count the number of egg-galleries bored, as the bark and sapwood were riddled by the interlacing galleries. All the stages of larva, pupa, and beetle were found, and also mature beetles just boring into the stems to lay eggs. This would seem to confirm my theory that the generations in one year of the life history of this insect overlap one another, since it would seem probable that the larvae were those of the second generation, the first lot of grubs appearing somewhere about the beginning of May. This would mean that the August-September larvae are those of the third generation, and the November beetles those probably of a fourth, which lay the eggs of the beetles which issue at the end of April in the following year. The *Pityogenes* was equally numerous in the neighbouring blue-pine saplings. As in the case of *P. major*, the fact that this beetle attacks the deodar in addition to the blue pine greatly adds to the importance of the pest, and renders it essential that its life history should be understood.

I found that a number of the dead deodar-trees killed during a bark-beetle attack in the years 1907–1908 and examined in the forests at Bre in Chamba in 1909 had been badly infested by this beetle, which had evidently swarmed in large numbers.

This *Pityogenes* infests also the *Pinus gerardiana* in the North Zhob and Takht-i-Suliman forests, and also in Bashahr in the North-West Himalaya. In the North Zhob and Takht forests the beetle was extremely plentiful in 1905, accompanying the *Polygraphus trenchi* (p. 510) and *Phloeosinus* beetles in their attack on the trees. Its life history in the chilgoza is very similar to that in the blue pine.

The protection and remedial measures are similar to those already described for *Polygraphus major* and the *Tomicus* beetles.

Parasitic and Predaceous Insects.

Chalcid.—The larva of this small fly is parasitic upon the grubs of the *Pityogenes*.

Fly.—A brightly coloured little insect. Head black with a minute yellow pubescence Eyes large, pink. Thorax and body dark metallic purple ; thorax beneath is rather yellowish, as are femora on inner surface ; tarsi yellow, the last joint black ; tibiae black, yellowish black above. Antennae angled, black with yellowish pubescence. Abdomen rounded, produced into a blunt point. Wings membranous, iridescent, upper with a black stigma and a few cells.

Life History.—I have taken this insect in the pupal chambers of the little *Pityogenes* in blue-pine trees in Jaunsar. The tiny fly either lays her eggs near the entrance-hole of the beetle or, more probably, crawls down it and lays them in the pairing-chamber. The larvae feed as external parasites on the scolytid grubs, which do not die before they have hollowed out the pupating-chamber in the bast layer. The parasitic grub then pupates in this, the scolytid larva dying.

Thanasimus himalayensis, Steb.—I have fed the *Thanasimus* beetles with this small *Pityogenes*, which they devoured as readily as they do the larger bark- and wood-borers they prey upon (p. 508).

Reduviid.—This insect occurs occasionally very plentifully in the galleries of the *Pityogenes* in blue pine and more rarely in deodar, and also with *Crypturgus pusillus* and *Polygraphus pini* in blue pine and spruce.

Young Insect.—Minute, elongate, shining ; head, thorax, and first segment of body reddish yellow, rest of body with a purplish metallic tinge dorsally and dark reddish underneath. Head with prominent eyes and a curved scimitar-shaped proboscis ; antennae yellow.

Mature Insect.—Small, flat, elongate. Black or greyish black. Antennae inserted in front of eyes on the head, the beak black, strong, and curved. Thorax triangular, narrowest in front. Scutellum triangular, produced into a sharp point backwards. Femora thickened.

Life History.—This small bug is sometimes found in considerable numbers in the tunnels and

FIG. 359.—*Reduviid*, predaceous upon *Pityogenes coniferae* and other scolytids (magnified).

North-West Himalaya.

galleries of the *Pityogenes*. It is an active and very wary insect, running in the burrows with great speed. It feeds upon the larvae of the scolytid, piercing them with its strong proboscis and sucking their body contents.

Pityogenes scitus, Blandford.

REFERENCE.—Blandford, *Ind. Mus. Notes*, vol. iii, p. 63 (1893).

Habitat.—Sibsagar, Assam.

Tree Attacked.— *? Pinus khasya*. Sibsagar.

Description.

Beetle.—Sub-elongate, shining, sub-glabrous, piceous black, the antennae and legs ferruginous. Closely resembles *P. chalcographus*. The forehead in female has three strong foveae with a central space raised, smooth and dull. The prothorax is narrowed anteriorly, the punctures on the posterior half close, well marked, and rugose ; the interspaces filled with very fine punctures, only visible under a high magnification. Elytra testaceous yellow, sometimes with a distinct dark lateral border ; flatter, less shining, and the rows of punctures not so distinct or regular as in *chalcographus*, the punctures becoming obsolete near the apex ; the apical depression three-toothed. In the male the forehead is convex, rugulose-punctate ; the elytra are testaceous, strongly infuscate along lateral margin, and for the whole of the apical declivity they are slightly narrower and flatter, the apical depression is shorter and more vertical, and the teeth are situated farther back and closer to each other, and the anterior pair point directly backward instead of obliquely upwards, and their base is longer. Length, 1.7 mm. to 2 mm.

Life History.

Somewhere about 1886 some specimens of this insect were reported by the Deputy Conservator of Forests, Sibsagar, Assam, as injurious to the makai (*Shorea assamica*). The beetles were sent on 4 April to the Indian Museum, through the Director of the Imperial Forest School, Dehra Dun. The insects were forwarded to Mr. W. F. Blandford, who found the species to be new to science.

Indian Museum Notes has the following reference to this scolytid :—

> " The insect was originally sent to the Indian Museum as attacking the *Shorea assamica* tree in Sibsagar, Assam. On Mr. Blandford's noticing, however, that other species of *Tomicus* and *Pityogenes*, in the modern limits of these genera, are only to be found in conifers, some small pieces of stick that were originally forwarded with the insects were sent to the Royal Botanical Gardens, Sibpur, for further examination. Here they were kindly looked at by Dr. George King, who found that they do not belong to the *Shorea assamica* tree, but possibly to the *Pinus khasya*, the sticks, however, not being sufficient for precise identification. The tree, therefore, that is attacked by *Pityogenes scitus*, Blandford, though not definitely ascertained, is, no doubt, one of the conifers."

Beyond the fact that this beetle appears on the wing some time in March, nothing appears to be known about its life history, which will, in all probability, resemble that of *P. coniferae*.

CHAPTER XXI.

RHYNCHOPHORA (*continued*)—Family SCOLYTIDAE (*continued*).

Tribe SCOLYTINAE (ECCOPTOGASTRINAE).

TIBIAE with the outer edge smooth; front tibiae lengthened out on outer edge with a one- or two-toothed hook. Abdomen flexed upwards.

The tribe includes the important genus *Eccoptogaster*, better known as *Scolytus*. The genus contains three Indian species which are serious pests of the deodar.

SCOLYTUS.

Scolytus (Eccoptogaster) major, Stebbing.

REFERENCES.—Stebbing, *Ind. For. Mem.* Zool. Ser. vol. i, pt. ii, p. 21; id. Bark-bor. Beet. Attack, Simla Catch. Area, *For. Bull.* no. 2 (1908); *Scolytus* sp. *Ind. For.* vol. xxvi, p. 560; vol. xxvii, pp. 26, 132, 231, 344; *Depart. Notes*, vol. i, pp. 45, 203.

Habitat.—Throughout deodar forests of North-West Himalaya.

Tree Attacked.—Deodar (*Cedrus deodara*). North-West Himalaya.

Description.

Beetle.—Black, shining; elytra dark red-brown or black. Front of head flat, impressed over mouth; a faint median elevate longitudinal line on front which does not reach the mouth or vertex, bounded on either side by an area very finely longitudinally striate; rest punctate, punctures finer on vertex, a shallow depression medianly on vertex just above basal margin. Prothorax constricted and impressed on anterior lateral margin; very smooth and shining except for a rather thickly punctate and slightly rugose area behind anterior margin, this punctured area stretching down diagonally on either side and being intercepted medianly by a narrow longitudinal smooth space, a prolongation from the smooth area on disk. The whole of the latter finely pitted, the punctures rather scattered and more abundant laterally; a few longish scattered hairs laterally in anterior portion. Elytra impressed medianly at base, slightly narrowed behind, the outer margins of apical fourth finely serrate, apices separately rounded; striate-punctate, the striae not prominent and punctures shallow, not very conspicuous and confluent at apices; covered with irregular scattered hairs, most abundant laterally. Abdomen with anterior margin of first segment prominent and produced forwards and thickened, rugose, shining, second segment concave, third and fourth with a small lateral tubercle on posterior margin, fifth flat, apical edge incurved medianly. Legs brown to blackish. Antennae and tarsi rufous brown. Length, 4.25 mm. to 4.5 mm. Pl. lvii, figs. *c* 1, *c*, *d*, shows the dorsal and side view of the beetle.

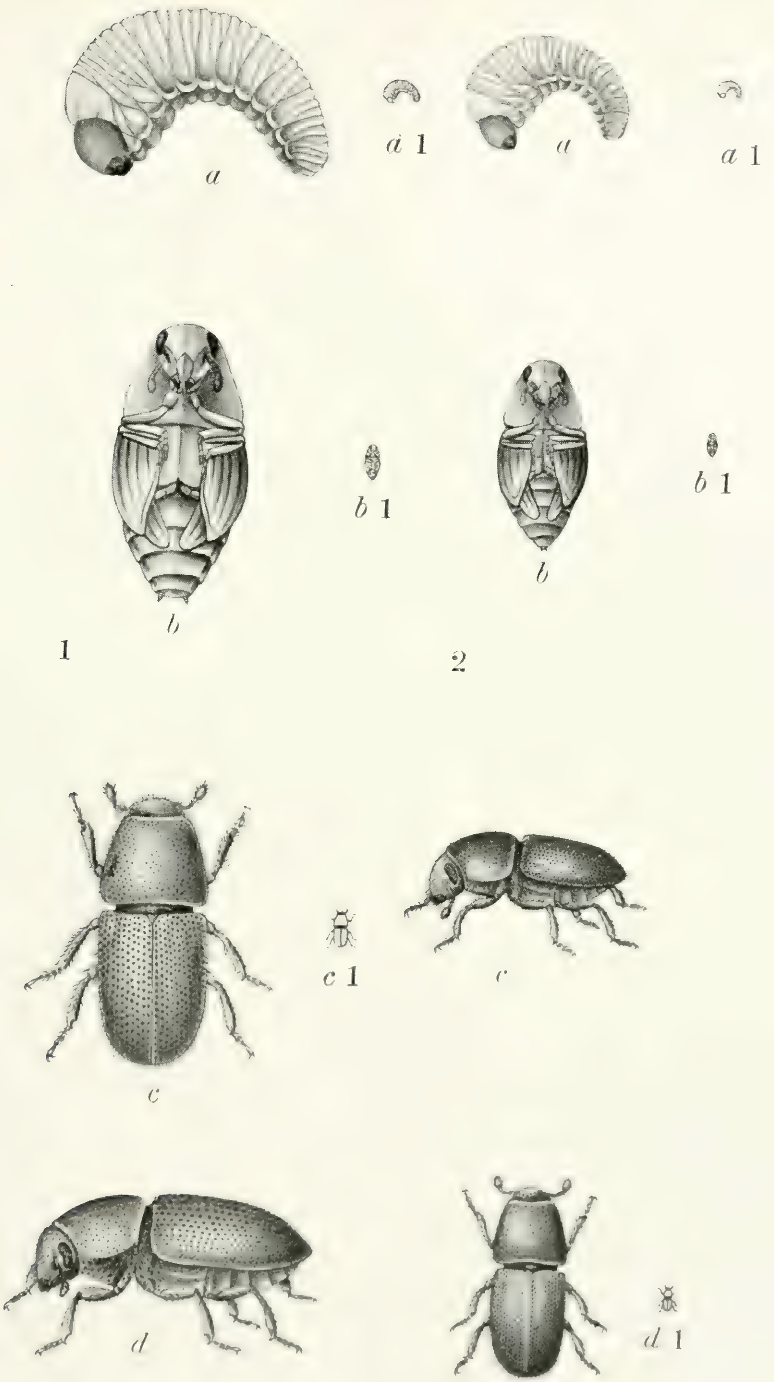
Egg.—The egg is spherical in shape, yellow in colour, and shining. It is very small, being about 0.8 mm. in diameter.

Larva.—The larva is small, curved, legless, and white in colour. It is largest across at the head end. When full-grown it is from $\frac{1}{5}$ to $\frac{1}{4}$ in. long. On first hatching out the grub is a minute white dot. The curved shape is, however, easily recognizable by the time it has bored about [illegible] in. away from the egg gallery. The larva natural size and enlarged is shown in figure.

Pupa.—The pupa is white and has the general shape of the beetle; but all the parts are soft, the legs, antennae, and wings being held pressed against the breast as shown in figure. Length, 4 mm.

The immature beetle when it is in the resting stage is light yellow and then light brown, gradually darkening to black as the outer parts harden.

PLATE LVII.



1. *Scolytus major*, Steb., in deodar.—*a*, *b*, larva and pupa magnified; *a*1, *b*1, natural size; *c*, *d*, female beetle, enlarged; *c*1, natural size. 2. *Scolytus minor*, Steb.—*a*, *b*, larva and pupa, enlarged; *a*1, *b*1, natural size; *c*, *d*, female beetle, enlarged; *d*1, natural size. North-West Himalaya.

Life History.

The deodar bark-borer passes through the winter either as a larva at the end of its gallery in the bast layer of the tree or as a mature beetle in the thicker parts of the old bark of deodar-trees. The beetle bores into this old bark to obtain a shelter from the cold of the winter months, and hibernates in this position. As soon as the first warmth of spring makes itself felt the over-wintering larvae change to pupae in their galleries, and then, in a week or ten days, become mature beetles and bore their way out of the tree and seek other trees in which to lay their eggs. A little before the latter beetles issue the mature beetles which have passed the winter in the old bark of deodar trees come out and seek suitable trees in which to oviposit. The eggs laid at this period are those of the first generation of the year. The exact time at which egg-laying begins varies according to whether an early or late spring is experienced. When a very early spring has followed a dry winter the beetles commence operations early in April, and female beetles which have wintered as such may be found boring into trees to lay eggs about the second week of the month. After a long cold wet winter followed by a late spring the *Scolytus* beetle will not commence laying the first eggs of the year before the fourth week or end of April.

The beetles pair outside the tree. The insect's method of attack from the outside and its operations within the tree are constant and are easily recognizable. As is usual with the bark-borers of this family, the female commences by boring a small "shot-hole" through the bark in order to reach the bast layer. This may be made anywhere on the tree (save in the smaller branches of the crown, which are not attacked), but the insect usually chooses a projecting flake of bark in order to screen itself. In the case of small saplings it bores in beneath a branch at the juncture of the latter with the main stem. On reaching the bast layer the beetle carries its gallery in an upward direction parallel to the long axis of the tree. The gallery is made mainly in the bast layer, but it also grooves more or less deeply the sapwood: it is deeper and stronger at its commencement than at the upper end. The gallery so made is the egg-gallery; it is from two to three inches in length and is carried upwards in a series of serpentine curves, first to one side and then to the other (cf. frontispiece and pl. lviii). The egg-galleries made in the boles of large trees are usually shorter than those made in saplings, poles, and branches. On either side of the egg-gallery, as she gnaws it out upwards, the beetle bites out small indentations in the wood, in each of which she places an egg surrounded by small fine particles of wood-dust; these egg-notches do not begin quite at the bottom of the egg-gallery, a small portion of it being left entire; they are, however, always made right to the extreme upper end, the number cut on either side being approximately identical. As the gallery progresses upwards the beetle keeps it quite free from particles of wood by shovelling out with her legs all the wood-dust, etc., eaten out in constructing it. This dust she ejects through the entrance-hole in the bark; a portion of these wood particles is also passed

through the body of the insect and ejected. The white and yellow wood particles thus thrown out can easily be seen in little heaps on the outer bark. When the beetle has finished egg-laying she does not die, but remains in the egg-gallery or entrance-tunnel in the bark, both of which she keeps quite free from wood-dust. The mother beetle may be found alive in the tunnel when most of the larvae from the eggs she has laid have become full-grown and are pupating. The beetle probably remains alive in order to protect the eggs and larvae from predaceous insects such as the *Niponius canalicollis* beetle (cf. fig. 331), who could otherwise enter the exposed gallery from the outside to oviposit or destroy the larvae it contains. When she finally dies it is usually in the entrance-tunnel in the bark, which she thus blocks up effectually, as with a cork. The egg-gallery takes from five to seven days to make. The larvae hatch from the eggs within a couple of days: young larvae from the eggs first laid may be found already hatched out and boring their galleries whilst the mother is still completing the egg-gallery above and egg-laying.

Between 70 and 85 eggs are laid in the egg-gallery, approximately 35 to 42 or 43 on each side. The larvae on hatching out bore in the bast and sapwood; they carry their galleries in a direction away from the egg-gallery, those in the centre eating away in a direction more or less at right angles, whilst the galleries of those above and below trend away from the right angle in an upward or downward direction. In this way an invariably uniform and constant pattern is made, which remains indelibly impressed on the sapwood (cf. frontispiece and pl. lviii). The presence of the beetle in a forest is thus recognized and identified with ease from these patterns which it leaves behind it in the trees it has attacked.

The larval galleries curve irregularly to a slight extent, and increase in size with the growth of the grub; at the end where the larvae are full-grown they are about the same width as the egg-gallery or slightly wider, and are from $2\frac{1}{2}$ in. to $2\frac{3}{4}$ in. in length. The galleries made by the larvae from the first-laid eggs are the strongest-marked and often the longest. When full-fed the larva changes to a pupa at the end of its gallery. In the case of large trees the gallery may be slightly enlarged at the extremity, a small depression being eaten out in the bark or sapwood. In poles, saplings, and the upper parts of large trees the grub appears invariably to bore down into the sapwood at the end of its larval gallery, eating out a small tunnel or chamber of sufficient size to take its entire body; having done this it backs out from the chamber so made, turns round, and backs down into it again and then pupates. The larva takes about four weeks to reach full growth. The beetle on maturing crawls out of the chamber and bores its way straight through the bark of the tree and flies off to find a mate and, if a female, to lay eggs in a fresh tree. The time passed in the pupal stage is about two weeks, the total period of a generation from egg to mature beetle being about six or seven weeks.

Stem of a young deodar (*Cedrus deodara*) showing the egg-tunnels and larval galleries of *Scolytus major*, Steb., on the sapwood. Some nearly mature beetles are seen in the pupation-chambers at the end of the larval galleries. Towards the base of the stem a larval gallery of the buprestid *Sphenoptera aterrima*, Kerrem., is seen with the entrance-hole to the pupation-chamber in the wood above it. Chamba, North-West Himalaya. M. L. Stebbing *del. et pinx.*

The above describes the life history of one generation or life-cycle of the insect, but does not account for the life of the species throughout the year. It has been found that it passes through several generations in a year, the actual number depending upon the climatic conditions of the early and late parts of the season.

My observations, carried over a series of ten consecutive years, tend to indicate that in ordinary years the insect passes through three to four generations (the last a partial one) in the course of a year, as follows :—

GENERATION I.

4th week in April	Eggs
1st week in May to 1st week in June	Larvae
1st week in June to end of June	Pupae
3rd week in June to 1st week in July	Beetles

GENERATION II.

4th week in June	Eggs
1st week in July to 1st week in August . . .	Larvae
1st week in August to 3rd week in August	Pupae
2nd week in August to 4th week in August . . .	Beetles

GENERATION III.

3rd week in August	Eggs
4th week in August to 4th week in September . . .	Larvae
4th week in September to 3rd week in October . . .	Pupae
2nd week in October to 4th week in October . . .	Beetles

GENERATION IV (a partial generation).

3rd week in October	Eggs
4th week in October to 2nd to 3rd week in April of the following year	Larvae

(Most of these larvae will be overwintering larvae.)

If beetles of this generation mature it will probably be from eggs laid in the 1st or 2nd week of October, when the generation would be as follows :—

1st week in October	Eggs
2nd week in October to 2nd week in November . . .	Larvae
2nd week in November to 4th week in November . .	Pupae
3rd week in November to 3rd week in April of the following year	Beetles

(These beetles will hibernate in the thick outer bark of old standing trees.)

Damage Committed in the Forest.

S. major is a most dangerous pest to the deodar, and is, as far as is at present known, one of the worst insect foes the tree has to contend with. Trees of all sizes are attacked by the beetle, from the largest tree in the forest to the smallest sapling. It usually confines its attacks to sickly trees and trees broken by snow or from other causes, in all of which the vitality has become lessened and the upward flow of sap consequently decreased ; it also invariably lays its eggs in newly felled unbarked trees when such are available. In forests where such trees are not available or where circumstances have favoured the

insect, such as a long drought and warm winter followed by an early spring, the latter will increase in such numbers that the ordinary supply of trees suitable for egg-laying becomes insufficient: the beetle will then attack green standing healthy trees. When this happens it is usually found that the insect chooses those which are growing on exposed aspects, especially dry southern aspects where the soil is poor, and those growing in open forest. Once, however, a centre of attack has started, the insect, by means of successive generations, spreads outwards from the centre in more or less concentric rings, each generation attacking the trees nearest to those in which it was reared. The attack on the deodar in Bashahr by this beetle, reported by Mr. B. Ribbentrop, C.I.E., Inspector-General of Forests, and Mr. Minniken, spread in this manner. In this way in serious attacks of the insect whole areas of forest may be killed off in a few months owing to the incredible swiftness with which the beetles multiply. That this latter is very rapid will be understood when it is stated that a tree of 3 ft. diameter at base and 100 ft. bole produced, as a result of a single generation reared in it, 56,300 beetles, allowing for 50 per cent. casualties. Observations have shown that in a dry year the casualties are from 15 to 20 per cent. only. Fig. 26, p. 49, shows the effects of the insect's attacks on young deodar in the Simla Catchment Area in 1908. The trees shown were killed by the beetle.

Protection and Remedies.

Once the life history of this beetle is well understood the introduction of certain measures to check its further increase on a large scale becomes possible. It is obvious that any measures which will result in the killing off of the grubs before they change to pupae and beetles will result in the disappearance of the insect from the area as a pest, since there will be no further egg-laying on a large scale. Our present knowledge of the life history enables us to cope with the pest in this manner. I have shown already that three full generations and a partial fourth may be expected in an ordinary year.

I have also given the approximate periods at which the larvae of each generation will become full-grown. In order to deal with an attack which threatens to assume serious proportions it will be necessary therefore to take steps to destroy the larvae of each generation as it appears.

The beetles may be attacking trees in any one or all of the following conditions:—

(a) Newly felled or fallen green trees (wind- or snow-breaks).
(b) Standing sickly trees.
(c) Standing green trees in the neighbourhood of a "centre" of infection.

The first step to be taken, then, is to seek out and mark all infested trees, both felled and fallen, and standing sickly or attacked healthy trees.

(a) *Newly Felled Trees and Windfalls.*—The first of these are known, as they will be in felling areas. The windfalls must be searched for and located. This will involve going carefully over the entire area.

(b) *Standing Sickly Trees.*—Whilst searching the area for windfalls a look-out will be kept for standing sickly trees, and all such will be marked with a tar ring or any other suitable mark. It cannot be hoped that all these trees will have been located and marked in time to catch the first generation of beetles to issue after the attack was first discovered. If, however, this generation is not caught, it should be possible to have marked all these trees in time to catch the larvae of the second or third generation.

In both the above cases the trees will be left *in situ* until they are known to be full of grubs : the approximate dates are given under the life history ; (b) trees are then felled and both (a) and (b) barked, and the inner face of bark turned outwards so as to expose it to the sun. Both larvae and pupae will be killed. Saplings and branches which are too thin to bark should be stacked and burnt. None of the standing trees should, however, be felled until they have become really badly infested by the beetle, even if this involves leaving them standing over two or more generations. They thus serve the purpose of trap trees.

(c) *Green Standing Infested Trees.*—Newly attacked green standing trees are more difficult to deal with. Their removal depends entirely on the degree to which they have been attacked and on their proximity to a bad "centre" of infection. Also it is difficult to mark down these trees until they commence to fade, when the bright yellow needles attract attention to them. When any such trees are discovered it is advisable, if they are not very severely attacked, to leave them standing over several generations of the beetles, for as soon as their vitality becomes lowered to an appreciable extent they will attract beetles to oviposit in them and thus serve as trap trees. This will prevent the beetles from going to as yet uninfested trees.

Trap Trees.—In order to ascertain definitely and rapidly the extent and intensity of an attack, green trees in suitable positions should be chosen here and there throughout the area, preferably along a road or footpath where they are easily reached and felled. These trees may be chosen at any time, but they should only be felled a few days before a period at which it is known that a generation of the beetles will be on the wing in the forest searching for trees in which to oviposit. It will be found that the beetles will unerringly detect the presence of these felled trees and will oviposit in them. These trees are termed "trap" trees. As soon as they are full of completely grown larvae or of pupae, they should be barked and the bark exposed to the sun or burnt, as may be most advisable. If a trap tree is not seriously infested by the generation of the beetles issuing soon after it was felled, it may be left to catch the next generation. The trees should be so felled as to lie in a position sheltered from the sun during the hot portion of the day. They should not be felled in dense shade, as in that event the beetles will not resort to them to oviposit.

In choosing the trees only such as have a fair flow of sap in the bast should be selected. To fell nearly dead trees for this purpose will be useless, as the bast layer would rapidly dry and the beetles will not oviposit in them. They will only lay in fresh sappy cambium.

To recapitulate :—

The periods to fell trap trees are as follows :—

1st generation	4th week in April.
2nd ,, ...	4th week in June.
3rd ,, ...	3rd week in August.
4th ,, ...	1st to 3rd week in October.

The periods to fell and bark sickly trees containing full-grown grubs, to bark fallen or trap trees, and expose the bark to the sun or burn it, are as follows :—

1st generation	1st week in June.
2nd ,, ...	1st week in August.
3rd ,, ...	4th week in September.
4th ,, ...	2nd to 3rd week in November.

It must be remembered that these periods will necessarily vary a little with differences of elevation, aspect, and climatic conditions, the various stages in each generation being more forward in a dry year than in a cold wet one. Also a greater number of generations will be passed through at the lowest elevations at which the deodar is found.

To ascertain whether the time has arrived to bark sickly fallen and trap trees, strip off a piece of bark and examine the larval galleries to ascertain whether they have nearly reached their full length. If they have, the time has arrived to bark the trees and burn the bark.

Bracon sp.—The grub of this fly feeds as an external parasite upon the larva of *Scolytus major*, finally killing it.

Parasitic and Predaceous Insects.

Fly.—Small, black, with long brownish yellow legs and two pairs of veined iridescent wings. Body thin, with the apical segments curved downwards. Length, 5 mm. ; wing spread, 8 mm. (Fig. 361.)

Larva.—A small white grub pointed at both ends, segmented. Length, 2.4 mm. (probably not full-grown).

Cocoon.—Ovate, elongate ; greyish brown, the surface of a parchment-like consistency covered with small, fine, ligneous fibres. Length, 6 mm.

× 4 b

a

FIG. 360.—Bracon sp., parasitic on *Scolytus major*, Steb. *a*, *Scolytus* larva with Ichneumon grub feeding parasitically on it ; *b*, cocoon. North-West Himalaya. (After E. P. S.)

Life History.—I first obtained some cocoons of this insect from larval pupating-chambers of the scolytid in deodar-trees at Pajidhar in Jaunsar, but failed to breed any flies from them, the cocoons drying up.

I again found the insect in the Simla Catchment Area forests in August 1908. I took from one of the galleries a nearly full-grown *Scolytus* grub, fixed to the side of which was a small white hymenopterous grub pointed at both ends. It was about a third the size of the *Scolytus* larva and was stuck to it, feeding as an external parasite as shown in fig. 360, *a*.

When full-grown the *Scolytus* grub eats out in the bast and sapwood a pupating-chamber in the manner already described and then dies of exhaustion. The parasitic grub then spins a small oval papery cocoon in the pupating-chamber of the *Scolytus* larva and pupates here. The fly matures in about a fortnight and crawls out of the tree by one of the neighbouring exit-holes of the newly matured *Scolytus* beetles.

FIG. 361.—Bracon sp., parasitic on *Scolytus major*, Steb. Fly natural size and enlarged. North-West Himalaya.

After pairing, the female Braconid fly searches for a tree into which the *Scolytus* beetles are tunnelling to oviposit, crawls down one of the entrance-holes, and deposits her eggs in the egg-gallery of the *Scolytus* near the latter's eggs. On hatching out, each of the parasitic grubs crawls to one of the young *Scolytus* grubs and fixes itself to it.

So far as my observations go the parasite appears to pass through as many generations in the year as its host. Whenever I found a tree badly infested with *Scolytus* tunnelling in it to oviposit I invariably observed some of these flies hovering over the trunk searching for a suitable entrance-hole to crawl into.

Chalcid.—I have also taken specimens of an unidentified Chalcid fly and grubs from the larval galleries of this scolytid.

Niponius canalicollis, Lewis.—This histerid beetle, which has been already described on p. 507, is one of the chief predators on *Scolytus major* and *S. minor*, entering the tunnels of the scolytids to oviposit in them.

The grubs of the *Niponius* feed on those of the *Scolytus*. The histerid is black and shining, and has a superficial resemblance to the scolytid.

Platysoma rimae, Lewis (p. 105).—This insect is fairly plentiful in the Western Himalayan coniferous region. It is predaceous upon *Scolytus major* and *S. minor*, and other coniferous bark- and wood-borers.

Beetle.—Flat, compact, somewhat elongate, black and shining; all parts of the insect fit well together. Head is transverse and narrow and provided with stout black mandibles and two elbowed antennae, each of which ends in a club. Thorax is wider than long, smooth in the centre with a few scattered punctures, these latter more numerous and larger at sides between the two broad shallow striae. Elytra twice as long as thorax, glabrous medianly, with very fine punctures, the sides with three longitudinal prominent striae, the surface being punctured between them; the elytra leave two segments of the abdomen and a portion of a third visible dorsally, these segments are constricted posteriorly, the surfaces being finely punctured. Length, 4.5 mm. to 6.2 mm.

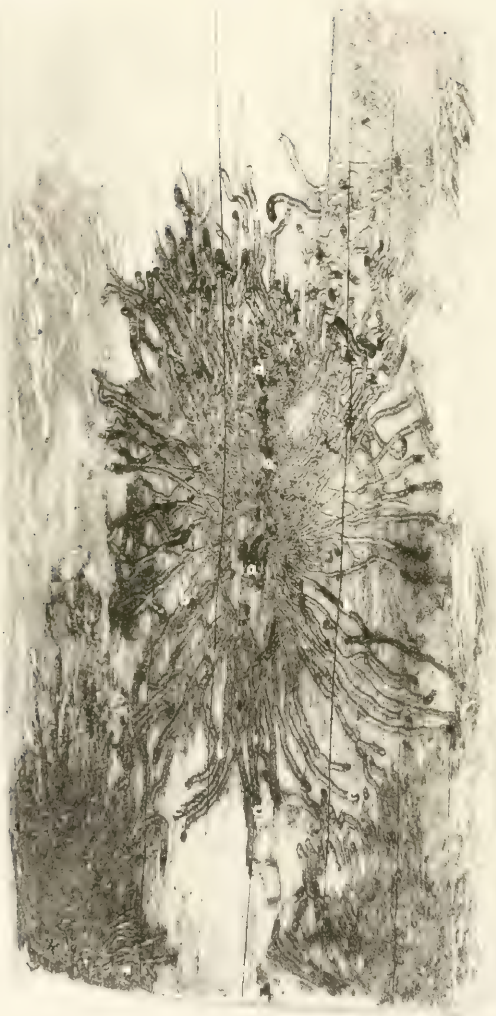
FIG. 362.—*Platysoma rimae*, Lewis, predaceous upon *Scolytus major*, Steb. North-West Himalaya.

Life History.—The first generation of the year of this histerid beetle is to be found in various species of conifers in May. A second generation has been taken towards the end of June in newly felled deodar-trees which were infested by the *Scolytus* bark-borers ovipositing in the trees. The histerid beetles were found in the egg-galleries of the bark-borers, and were apparently engaged in laying their eggs in the tunnels. It is probable that the histerid grubs feed on the larvae of the *Scolytus* and the beetles perhaps on the eggs.

But little is at present known about the larval and pupal stages of the beetle. I think it possible that the number of generations in the year coincides with those of the *Scolytus* insects.

The insect, owing to its abundance in the trees and to the fact that it appears to be predaceous upon several bark-boring beetle pests in the Himalayan region, is evidently of considerable importance in the forest.

Thanasimus himalayensis, Steb.—This clerid beetle has been already fully described on p. 508. It is one of the most important of the *Scolytus* predators, and is commonly to be found flying over or running about on felled or fallen green deodar-trees which are infested by the two *Scolytus* bark-borers *S. major* and *S. minor*.



Slightly under ½ nat. size.

Photogravure Survey of India Offices, Calcutta, February 1913

[illegible] GALLERIES OF *SCOLYTUS* [illegible] *STEB.*

[illegible] *STEB.* IN [illegible]

Scolytus (Eccoptogaster) minor, Stebbing.

REFERENCES.—Stebbing, *Ind. For. Mem.* Zool. Ser. vol. i, pt. ii, p. 22; *Depart. Notes*, vol. i, p. 207.

Habitat.—Deodar Forests of the North-West Himalaya.

Tree Attacked.—Deodar (*Cedrus deodara*), North-West Himalaya.

Beetle.—This insect greatly resembles the larger *Scolytus*, the eggs, larvae, and pupae presenting no differences of importance. The beetle has the following differences in external characters:—

Description. Smaller than *major*, which it greatly resembles, the elytra usually darker in colour to nearly black. The front of head presents differences. In the female there is no median longitudinal line or striate area or median depression near basal margin on vertex; the front is uniformly and rather coarsely rugose (at times almost tuberculate), except on vertex, which is punctate; a few yellowish hairs over mouth. Prothorax constricted and rounded anteriorly, the thickly rugose and punctate area on the anterior margin broader than in *major* and not interrupted by a longitudinal median smooth area, the disk less shining than in *major* and the punctures finer and more numerous. Elytra differ from *major* in having the punctations not confluent and very much smaller; they are more regularly spaced, but wider apart in the rows, becoming finer apically; the serrate margins of apical fourth more marked. The first segment of abdomen less rugose-punctate than in *major*, the posterior margins of third and fourth segments thickened throughout their entire length without a median or posterior tubercle. Length, 2.5 mm. to 3 mm. In pl. lvii, figs. *a–d*, *a*1, *b*1, *d*1, show the larva, pupa, and beetle, enlarged and natural size.

Save in size and the appearance of the front of the head and the disposition of the punctures on the thorax, this species is scarcely distinguishable from *major*. The difference in size and the other points of divergence appear, however, to be constant.

Life History. The method of oviposition and the plan of the egg and larval galleries resemble those of *S. major*, the differences being that the egg-gallery is shorter in length, being rarely over an inch long and usually even less, and the number of eggs laid averaging about thirty-five to forty, i.e. from seventeen to twenty are deposited on each side of the egg-gallery.

The time taken to pass through one life-cycle and the number of generations passed through in the year resemble those of *S. major*.

Parasitic Insect. **Bracon** sp.—Some nearly mature species of a Bracon fly were found in a deodar sapling at the end of the first week in June in the pupating-chambers at the end of the larval galleries of the bark-borer *Scolytus minor*. The tree was growing at a low elevation, and the eggs were probably laid at the beginning of May. The insects were too immature to identify further with any certainty. These flies are evidently parasitic upon the larvae of the small *Scolytus* beetle. The eggs are laid by the female insect, who probably pierces through the bark and deposits them in the larval tunnel, or she may place them in the entrance-tunnel. The young maggot feeds upon the larva, and does not kill it until it has reached its full growth and gnawed out its pupal chamber.

The other insects mentioned under *Scolytus major* are predaceous upon this scolytid.

Scolytus (Eccoptogaster) deodara, Stebbing.

REFERENCES.—Stebbing, *Ind. For. Mem.* Zool. Ser. vol. i, pt. ii, 23; id. *Depart. Notes*, vol. i, 220.

Habitat.—Jaunsar, Simla Hill States, Bashahr, Chamba. North-West Himalaya.

Tree Attacked.—Deodar (*Cedrus deodara*).

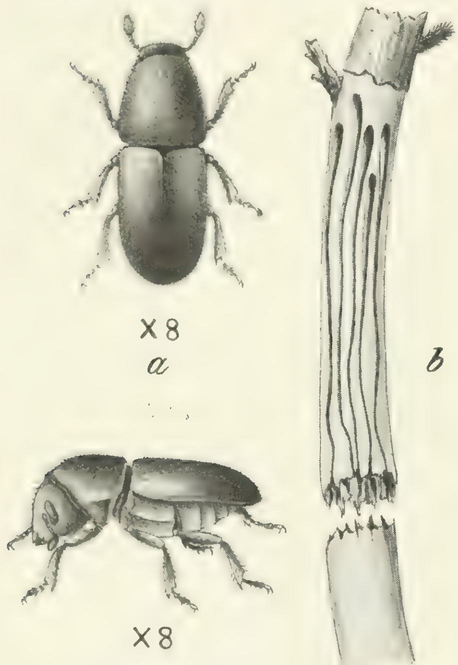


FIG. 363.—*Scolytus deodara*, Steb. *a*, dorsal and side view of beetle; *b*, part of girdled shoot showing point of girdle and larval galleries in sapwood above girdle (bark removed).

Description.

Beetle.—Intermediate in size between *S. major* and *minor*. Black, moderately shining, cylindrical, the elytra tinged with rufous brown. Head thickly striate behind the eye with close-set vertical striae which are produced down on to the ventral surface, this striation not being present in *S. minor*. Prothorax not longer than broad, not so thickly punctate as is head, the punctures finer and fewer behind. Elytra fairly thickly striate-punctate, sparsely covered with yellow hairs, especially laterally, as are prothorax and head. Antennae yellowish brown; legs rufous brown, tarsi yellow. Length, 3.2 mm. to 3.5 mm.

Larva.—When just hatched the young larva is a minute white circular ball.

Life History.

This beetle apparently makes its first appearance in the year in the forest about the middle to the third week of June, i.e. not long before the first burst of the monsoon rains. Its method of egg-laying is quite unlike that of the other two species of *Scolytus* known to infest the deodar.

The female beetle selects the leader of a sapling or the branch of a large tree which may have a thickness of as much as three-quarters of an inch in diameter, and proceeds to girdle it. The beetle tunnels first into the branch down to the cambium layer, and then eats out a deep groove in the bast and sapwood in a horizontal manner round the branch, this groove completely girdling the stem. The beetle manages to keep such an even course on its way round the stem that it usually hits off to within a fraction the point where it started from (*vide* fig. 363, *b*.) Small notches are cut out on the upper side of the groove and an egg laid in each. These notches are usually cut only on the shady or northern aspects of the branch, and the groove is generally deepest on this side, so that when the weight of the branch causes it to break and bend over it falls on this side. The number of eggs laid in one girdled branch is as many as eight, and may be a few more.

I have not yet been able to ascertain whether the beetle girdles more than one branch. After laying her eggs she leaves the branch by the hole of entrance, which is usually just above the groove.

That the young larvae hatch out from the eggs in a few days has been proved from the fact that quite young larvae are to be found boring away from the girdle whilst the cut branch is still fresh and green. The girdle is of course made by the beetle to prepare a sufficiency of food material in the withering condition required by its grubs on issuing from the eggs.

The larvae on hatching bore straight up the girdled branch (as shown in fig. *b*) in the cambium and sapwood, eating out slightly winding galleries about one and three-quarters to two inches in length. These larval galleries are blocked throughout their entire length with wood-dust and excrement.

When full-grown the larva eats out in the sapwood a chamber slightly larger than the gallery, and pupates in this. The beetle on maturing bores its way out by a horizontal tunnel through the bark.

The life-cycle of the generation from the eggs laid in June or commencement of July takes about seven weeks, beetles being obtained in the latter part of August from branches found freshly girdled on 3 July. The larval stage of this generation thus probably lasts from four to five weeks.

Occasionally it has been noticed that a branch has been girdled in two separate places, whether by the same beetle or not I cannot say. An instance of this is shown in fig. 365, A, 1 and 2.

During a tour in the Jaunsar Himalaya in the autumn of 1906 (September to middle of November), I found the beetles engaged in girdling branches and egg-laying at the end of October. This proves that there are two generations, or the whole of a first and a partial second, in the year. I am inclined to think that the August beetles lay the eggs of the second generation of the year and that the beetles found in October are from the August eggs.

The insect is extremely wasteful in its method of ovipositing. Large branches are girdled often two to three feet in length and with several forks or side branches on them. From the whole of this large cut branch but one and a half to two inches are grooved beneath the bark by the larvae as shown in fig. 363, *b*. The rest of the branch thus destroyed is, so far as this scolytid is concerned, entirely wasted.

As a matter of fact, however, the upper portions of these branches are very often infested by a second scolytid, *Cryphalus* (*Stephanoderes*), described on p. 540.

This *Scolytus* differs from the other Scolytidae known to infest the deodar in the fact that it makes its appearance very late in the year. I have never yet found the beetles ovipositing before the middle to the third week of June, whereas the other scolytid pests known commence laying the eggs of the first generation of the year towards the end of April. This late appearance may be due to the fact that this insect is

a branch girdler laying its eggs in the girdled portion of the tree. Since the monsoon bursts on the average about the end of June, the girdled branch would dry less rapidly, and consequently serve as food for the larvae hatching from the eggs for a longer period, if the eggs were laid just before the rainy season, than if they were laid in the early summer when the branch would be exposed to the full rays of the summer sun.

The only other period of the year at which I have found branches freshly girdled by this beetle is at the end of October. It may be that the trees are girdled some time during August (I have not been able to study the insect during that month) by beetles resulting from the eggs laid in June; and if so, this would indicate that the insect passes through two full generations and a partial third one in the year, the partial third generation resulting from the eggs laid at the end of October, the larvae from which either pass through the winter as such or develop into beetles which remain *in situ* in the branch until the following year.

FIG. 364.—A young 8 ft. Deodar Sapling with top girdled 16 in. down by *Scolytus deodara*, Steb. Jaunsar, N.W. Himalaya. (J. W. Oliver, photo.)

Damage Committed in the Forest.

This scolytid beetle attacks trees of all ages, but it is chiefly harmful to young growth, saplings, and young poles. These it more usually than not attacks at the top, girdling the leading shoot and thus spoiling the shape of the tree. I have seen a sapling which had had its leader and two subsequent leaders (formed by side branches replacing the last leader) girdled by the beetle.

In large trees its work is also easily recognizable. They may be observed to have a curious irregular shape owing to numbers of the branches having had their ends "cut" by this insect.

This curious raggedness in the shape of the tree is even more marked in the case of smaller trees, and the number of branches treated in this manner must seriously interfere with and retard their growth.

In saplings the maximum amount of damage is observable, as the girdling of the leading shoot and side shoots leads to misshapen trees which are easily recognizable in plantations. Fig. 364 shows a young sapling with its leading shoot cut off by this insect. The photograph was taken in the forest by Mr. J. W. Oliver, I.F.S. Fig. 365 shows the top of another sapling (from a photograph by Mr. H. Jackson, I.F.S.) in which two side shoots have taken the place of the girdled leader.

The work of the girdler is easily seen. If the end of the girdled branch is examined a portion of the groove made by the beetle is always discernible. Also owing to the deep groove cut by the beetle and the heavy weight of the needle-bearing branch above it, the latter very soon bends over and hangs down (until it does this there is nothing to show that the branch has been attacked, save the small entrance-hole from which resin exudes), attached by a few shreds of bark and wood to the branch below the cut, and a certain amount of resin exudes around the groove. This pendent position of the green branches renders fresh attacks at once perceivable in the forest, and more especially is it visible in young plantations. Consequently, the amount of damage being done by the beetles, once the life history is clearly understood, is easily discernible.

FIG. 365.—A, Deodar branch girdled in two places at 1 and 2 by the Deodar Branch Girdler (*S. deodara*). B, Leading shoot of a 10 in. deodar sapling girdled at 3 by *S. deodara*. Two side shoots are taking the girdled leader's place. Jaunsar, N.W. Himalaya. (H. Jackson, photo.)

A curious fact I have observed about the insect is that it appears to be very local in its distribution, occurring year after year in certain comparatively small areas of forest, and being apparently almost entirely absent from other regions. This point is of importance, since if it

is true it should be possible to ascertain its *local distribution* and exterminate it.

A second point of importance is that the insect has been found invariably in pure deodar forests, the greatest damage being caused in young pure plantations. It is much rarer in mixed forests, a point worthy of some consideration.

Sub-Family 3.—SAETIDENTATAE.

Edges of middle jaw fringed with bristles. The sub-family contains the tribes Corthylinae (at present unrepresented in the Indian forest) and Xyleborinae.

Tribe XYLEBORINAE.

The first joint of the labial palp swollen, and furnished on the inner side with a beard of hairs. Includes the very important and large genus *Xyleborus*, and the genus *Xyloterus*, of which one species only is known from India.

XYLEBORUS.

The genus *Xyleborus* includes a vast number of species of small form and great economic importance in the East.

Xyleborus fallax, Eichhoff.

REFERENCES.—Eichhoff, Ratio Tomic. p. 308 (1878). Stebbing (*Tomicus shoreae*), Undescr. Scolyt. Ind. For. *Ind. For. Mem.* Zool. Ser. vol. i, pt. ii, 16; id. Ass. Sál Ins. Pests, *For. Bull.* no. 11, p. 39.

Habitat.—Assam, Bengal Duars.

Tree Attacked.—Sál (*Shorea robusta*). Goalpara, Assam; Jalpaiguri Sál Forests, Duars.

Description.

Beetle.—Elongate, rather slender, with an elongate convex reddish thorax and dark piceous elytra. Prothorax one-fifth longer than broad. Moderately strongly rugose-punctate anteriorly with a few scattered yellow hairs; finely pitted on posterior portion with irregular fine transverse lines and striations. Elytra irregularly punctate, with an ill-defined stria not reaching base and the suture prominent. The apical declivity of elytra furnished with three prominent teeth on each side and three smaller ones. Some scattered hairs on the surface. Under-surface slightly punctate and sparsely pubescent. Legs and antennae yellowish red. Length, 3.1 mm. (Figs. 4 and 5, pl. l.)

Life History.

I have taken this insect only sparingly. Specimens were found on 16 May tunnelling down into the sapwood of a green sál-tree felled in the Kachugaon Forest on the 13th of the month. The beetles were tunnelling into the main trunk. Ranger B. Sen Gupta cut out some specimens of this insect from felled green sál-trees in the Jalpaiguri forests in the Bengal Duars. This is all the information at present available on the species.

Xyleborus perforans, Wollaston.

REFERENCES.—Wollaston, *Cat. Col. Mader.* 96. ♂ ♀ (1857); Blandford, *Bull. Roy. Bot. Gardens Kew* (Sept. 1890); *Xyleborus* sp., Stebbing, *Depart. Notes*, i, 406.

Habitat.—Siwaliks, N. India; Goalpara, Assam; Tharrawaddy Forests, Lower Burma; Mysore. Also reported from Bombay, Calcutta, Rangoon.

Tree and Wood Attacked.—Sál (*Shorea robusta*): Siwaliks and Goalpara: *Anogeissus latifolia*: Kadin Bilin, Tharrawaddy; *Areca catechu*: Mysore: Beer-casks.

Description.

Beetle.—Elongate, cylindrical. Red-brown. Head punctate, with a brush of hair over mouth. Prothorax semi-cylindrical, longer than broad; base truncate, the basal angles rounded, apex strongly rounded; anterior fourth with close transverse asperities, becoming less defined but continued to middle on sides, rest smooth, punctate, more closely so on sides; a sparse covering of spiny hairs anteriorly. Scutellum transverse. Elytra wider than prothorax behind, about half as long again, humeral angles rounded, sides slightly widened from behind

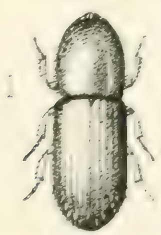


FIG. 366.
Xyleborus perforans, Woll. in *Anogeissus latifolia.* Tharrawaddy.

FIG. 367.
Xyleborus perforans, Woll. in *Anogeissus latifolia.* Tharrawaddy.

FIG. 368.
Xyleborus perforans, Woll. in *Areca catechu.* Mysore.

humeral angles to anterior fourth, thence rounded to apex; punctate, the punctures rather large and shallow; apical portion strongly but obliquely declivous and flattened and set with small pointed tubercles; the apical portion clothed with long sparse spiny yellow hairs. Legs red with sparse spiny hairs. Length, 1.9 mm. to 2.4 mm.

This little *Xyleborus* has a wide distribution in the country and appears to infest a number of timber species.

Life History.

In North India the beetle appears on the wing towards the end of April, this being in all probability the first generation of the year. The beetle tunnels down into the wood of the sál-tree and lays its eggs there. It usually goes straight into the wood; but at times, after reaching a certain depth in the sapwood, the beetle turns and carries the gallery at right angles to its former direction. If the bark is still on the log, this gallery may go through the bark in this manner instead of in the sapwood. It is carried for about a couple of inches, and then the beetle again changes the direction and bores down into the heart-wood. The insect does not appear to confine itself to fresh bark or wood for its operations, but at the same time I have not found it

in very dry wood. In the latter, old galleries of previous years were discoverable, but no new ones or beetles. From this it would seem to be possible that these wood-borers—and the same has been noted in several other instances—confine their attacks to a certain condition of the wood during its seasoning process. When the wood has reached a definite degree of dryness they will no longer attack it. The beetles when discovered on 24 April were egg-laying.

I subsequently found this *Xyleborus* in some numbers tunnelling into the sapwood of a green sál-tree felled on 13 May 1906 at Kachugaon, in Goalpara. The beetles were mostly taken between the 16th and 20th of that month. They were all found in the sapwood and had not yet penetrated down into the heart-wood. They were here tunnelling into absolutely fresh wood full of sap, apparently with the object of egg-laying.

Whilst in Lower Burma in 1905 I noticed this scolytid appearing in some numbers on the evening of 21 January just before sunset, in the Tharrawaddy forests. I obtained no specimens of the insect on subsequent evenings, and it became apparent that on the evening in question a swarm of this insect had just reached maturity and left the tree or plant the insect infests. The insects were flying around and inside the Myaungbinzin Bungalow, built of teak and thatched with grass, bamboos being used in the construction of the walls. The teak posts and rafters and the bamboos used in the construction of the bungalow were earth-oiled, so it was not definitely ascertainable that the insect came from either of them.

On the following day, however, I found the first beetles of the year mature and maturing in a large felled *Anogeissus* tree. The tree had been felled in a tounggya clearing in the previous year (May). These clearings are made in the forest with the object of creating teak plantations, the grantee being allowed to fell the trees, fire the area, and then to take a crop of rice off the area provided he sows on it at the same time teak seed at intervals of 6 ft. by 6 ft.

The wood of the large tree in question was still fresh, although the bark was dry in the upper part.

A few belated white curved larvae were also found at the bottom of the egg-tunnels. The female beetle tunnels straight through the bark down into the sapwood for a certain distance, and then the tunnel diverges to the right or left. At the bottom of the tunnel she lays four to six eggs. The larvae appear to be ambrosia feeders, as they do not feed upon the wood. The beetles, when mature, crawl up the mother egg-gallery and escape from the tree. The beetles mature and maturing on 22 January were issuing to lay the eggs of the first generation of the year, i.e. the first generation of 1905. The beetle was infesting the tree in company with the platypids *Platypus rectangulatus* and *P. solidus* (p. 623).

Specimens of this scolytid were sent to me by the Mycologist of the Mysore Agricultural Department, with the information that they seriously infested *Areca catechu* trees.

The life history of this insect, in reference to its attacks on beer-casks, had to a great extent been worked out by Mr. W. F. Blandford. In the latter part of the 'eighties of last century it was discovered that serious damage was being done to beer-casks in India. It was at first attributed to European scolytids of the genus *Typodendron*, and it was thought that the casks were riddled in Europe. Subsequent investigation brought to light the fact that in some cases the damage was done to the cask either on board ship, as casks were discovered to be leaking on being landed at Bombay, or after reaching India.

The beetle tunnels down into the wood to oviposit. The females eat out tunnels in the wood which branch a great deal.

This *Xyleborus* has acquired a world-wide reputation. It has been known for over thirty years as a destructive beer-cask borer in India, and occasionally causes considerable loss by riddling the staves, thus causing a leakage of the beer.* About 1892 it appeared in connection with another industry, that of the sugar-cane in the West Indies, where, under the well-known name of the "shot borer," it has committed serious havoc. In 1900 a *Xyleborus* was reported in this connection from Bengal, and it is considered to be either identical with, or closely allied to, *X. perforans*.

Whether an insect known to be a dry-wood borer will at the same time bore into a plant such as the sugar cane is a point open to very considerable doubt, and a careful examination of all the specimens so reported would appear to be required to set the matter at rest. As the writer pointed out, however, in an article on sugar-cane pests written in 1900, and published in the *Indian Museum Notes*,† if these should on further examination prove to be identical, it will greatly aid its increase should the wood it affects be lying in the neighbourhood after the removal of the green crop.

Relations to the Forest.

This *Xyleborus* is another addition to the lengthening list of the sál wood-borers. I first took it in April 1901, in a wood depot in the Siwaliks, attacking logs which had been felled in the cold weather of 1900–1901. Further observations are required on its life history in order that a correct estimate may be made as to the damage it is capable of doing to stores of wood.

Investigations in subsequent years tend to prove that the beetle commences its depredations on the timber whilst still green and full of sap. Up to what stage in the drying or seasoning of the timber it will continue its attacks is at present doubtful. The fact that, according to Blandford, this species attacks the dry seasoned wood of beer casks, that another report makes it a sugar-cane pest, whilst Sampson

* Vide *Injur. Ins. Ind. Forests*, p. 65. † *Ind. Mus. Not.* v, p. 72.

identifies the species tunnelling into half-dry and green sál wood in the Siwaliks and Goalpara (two localities with very different climates), green *Anogeissus* in Tharrawaddy, and green *Areca* in Mysore, as *perforans*, considerably complicates the question of the true habits of the species. From the study of the habits so far as carried at present, I incline to the belief that the insect here given as *perforans* may possibly be found to consist of two or more distinct species or sub-species.

Xyleborus gravidus, Blandford.

REFERENCE.—Blandford, *Trans. Ent. Soc. Lond.* 427 (1898).

Habitat.—Chittagong Hill Tracts.

Tree Attacked.—Mahogany (*Swietenia mahogani*, Linn.). Kaptai.

Description.

Beetle.—♀ Short, robust, very convex, somewhat shining, bright reddish testaceous, the elytra ferruginous, darker posteriorly; pubescence sparse, fulvous. Head very large, globose; front more shining towards the mouth, with scattered rather large punctures; eyes oblong. Prothorax ample, broader than long, strongly convex, the sides slightly, the apex more strongly rounded, the latter with two prominent median blackish tubercles; surface with large transverse asperities anteriorly, closer towards the middle, posteriorly punctured closely and distinctly on sides, obsoletely medianly, where there is a dense tuft of short upstanding hairs just above the scutellum, the remaining pubescence scanty. Elytra strongly declivous and retuse from before the middle to the apex, about a third longer than prothorax, separately rounded at base; surface convex from the base to the declivity, with indistinct rows of feeble punctures, the flat interstices with finer scattered irregular punctures; declivity sub-abruptly rounded above into the cylindrical portion, margined at the sides and apex with an acute ridge; surface of declivity with sub-impressed rows of shallow punctures carrying long fine hairs, interstices flat. Under-side and legs testaceous, the tibiae closely and finely serrate. Length, 4.5 mm.

Mr. Blandford mentions that it is possible that the specimens from which he described the insect were immature, and that the colour of the beetle may be blackish.

Life History.

Specimens of this beetle, together with *Scolytoplatypus brahma* (p. 607), were sent to the Indian Museum from the Chittagong Hill Tracts by the Divisional Forest Officer with the report that they were destructive to mahogany-trees. I have been unable to trace the further history of the specimens. They in all probability came from Kaptai on the Karnafuli River, where there is a small mahogany plantation. I was never able, however, to find the insect there myself, although I searched for it on several occasions in 1899–1900.

The insects were sent from the Indian Museum amongst some Bostrychidae to M. Lesne at the Paris Museum for identification, and by him were forwarded to Mr. Blandford.

The insect may be identical with a scolytid which infests the mahogany at Nilumbur in Madras, but that has yet to be proved.

Xyleborus mancus, Blandford.

REFERENCE.—Blandford, *Trans. Ent. Soc. Lond.* 428 (1898).

Habitat.—Ceylon.

Tree Attacked.—Cocoa-tree (*Theobroma cacao*).

Beetle.— ♀ Front of head convex, sub-opaque, rather closely and finely punctate, with a short shining elevated longitudinal line above the middle of the shining blackish epistoma ; eyes rather deeply emarginate. Sides of the prothorax nearly straight behind the middle, with a black conspicuous patch of piliferous punctures near the base. Elytra darker apically, nearly black, the apical declivity not very opaque, not concave on either side, but gradually raised towards the suture, with a somewhat irregular surface, the rows of punctures somewhat wavy, the punctures rather large shallow subnitid impressions, the interstitial punctures not perceptible. Length, 3.3 mm.

Description.

Life History.

On a first study of diseased cocoa-trees in Ceylon, Mr. E. E. Green, Government Entomologist, forwarded to Mr. Blandford three species of Scolytidae and Platypodidae which he believed were responsible for the attack. The Scolytidae proved to be *Xyleborus semigranosus*, *Xyleborus fornicatus*, and *Xyleborus* (*Eccoptopterus*) *sexspinosus*. At the same time Mr. Green stated that he was not satisfied that the beetles were the real source of the disease, as a fungus was also present. Subsequently Mr. Green sent two other Scolytidae who were really responsible for the damage done. These proved to be new to science, and were described by Mr. Blandford as *Xyleborus mancus* and *Xyleborus discolor.*

On the subject of the damage done Mr. Green wrote :—

"I am of opinion that the beetles first sent were not primarily responsible for the injury, and this opinion has been corroborated by the discovery of a fungus in all the diseased specimens of bark submitted to Kew.

"I am now forwarding two more species of scolytid beetles that are found in the younger branches of the cocoa-tree, which really are injurious to the plant. They form their tunnels in what appears to be healthy wood, and rapidly cause the death of the parts attacked. A dark chocolate or purplish stain spreads through the tissues of the wood surrounding the galleries of the insect."

Xyleborus discolor, Blandford.

REFERENCE.—Blandford, *Trans. Ent. Soc. Lond.* 429 (1898).

Habitat.—Tista Division, Bengal (J. C. Carroll); Ceylon.

Trees Attacked.—Nahor (*Mesua ferrea*): Tista Division; Cocoa-tree (*Theobroma cacao*).

Description. **Beetle.**—♀ Very small. Short cylindrical, bright testaceous, elytra black. Head dull, the front rather finely punctate, with a fine raised median longitudinal line. Prothorax as long as broad, the sides nearly straight behind, gradually rounded to the apex in an ellipse; surface in front with small granular elevations, very finely punctured behind with a brush of short erect fulvous hairs medianly. Elytra as long as prothorax, cylindrical, abruptly truncate behind the middle, shining black, finely punctate, the punctures of the rows and interstices scarcely separable from each other; apex strongly declivous, circular, covered with very short fulvous pubescence and thence sub-opaque, finely striate, the interstices quite flat. Under-side and legs bright testaceous, the anterior tibiae narrow. Length, 1.8 mm.

The bright testaceous colour of body, black elytra, and fulvous downy pubescence of the sharply curtailed extremities, render it easy to recognize.

Specimens of this *Xyleborus* were forwarded to the Forest Zoologist, Dehra, together with *X. interjectus* and *Xyleborus* sp., by Mr. J. C. Carroll, I.F.S., from the Tista Division in Bengal, in August 1910. Only the beetle was obtained, it having been found infesting twigs of *Mesua ferrea*. Mr. Carroll wrote: "The inquiry is made in connexion with an extensive mortality which is occurring in this division amongst the nahor-trees, and I would mention that extensive fungal infection has also been found in the trees that have died. Whether the beetle attack follows the fungal attack or vice versa I cannot ascertain, and I should be glad of your opinion as to whether the beetle attack alone would be sufficient to cause the death of large trees."

As described under *Xyleborus mancus* above, this beetle was reported as causing injury to the branches of the cocoa-tree in Ceylon.

Xyleborus interjectus, Blandford.

REFERENCE.—Blandford, *Trans. Ent. Soc. Lond.* 576 (1894).

Habitat.—Tista Division, Bengal (J. C. Carroll). Also reported from Japan, China.

Tree Attacked.—Nahor (*Mesua ferrea*). Tista Division.

Description. **Beetle.**—Oblong, piceous black, shining, antennae and legs ferruginous. Thorax squarish, the sides and apex rounded, finely punctate anteriorly; elytra cylindrical, scarcely half as long again as the thorax, convex; striate-punctate, the lines of punctures non-impressed, the interstices flat, with long close seriate bristles, which arise even up to the base from punctures which have at least the anterior margin elevated, so as to be subtuberculate; apex obliquely depressed and convex, striate-punctate and tuberculate, the interstices scarcely convex. Length, 3.4 mm.

This species greatly resembles Eichhoff's *X. validus*, a common Japanese species infesting firs.

As already mentioned, *X. interjectus* was sent from the Tista Division by Mr. Carroll in company with *X. discolor*. It tunnels into the twigs of *Mesua ferrea*.

Xyleborus sp.

Species of *Xyleborus*, as yet undetermined, were sent in company with *discolor* and *interjectus* as infesting *Mesua ferrea* in the Tista Division.

Xyleborus semigranosus, Blandford.

REFERENCE.—Blandford, *Trans. Ent. Soc. Lond.* p. 211 (1896).

Habitat.—Ceylon. Also reported from Sumatra.

Tree Attacked.—Cocoa-tree (*Theobroma cacao*) (E. E. Green).

Description.

Beetle —Oblong, slightly shining, ferruginous red, darker behind. Front of head rather strongly punctured, the mouth fringed with pale hairs ; antennae pale testaceous. Prothorax as long as broad, strongly rounded at the apex, the sides very slightly curved, hind angles obtuse but not rounded, the base truncate ; surface with a very slight transverse median elevation, scantily but uniformly pubescent with fine hairs, in front convexly declivous with granular asperites, somewhat irregular and scattered towards the apical margin, behind the middle cylindrico-convex ; finely punctured, the punctures stronger over the middle portion, median smooth line absent. Scutellum triangular, shining. Elytra as wide as prothorax and about a third longer, base truncate, shoulders rounded rectangular, sides parallel, abruptly inflexed at apex, the apical margins sharply bordered below ; surface very finely and apparently confusedly punctate ; declivity beginning before the middle, depressed, opaque without evident striation ; very finely and closely granulate and set with single series of rather long upstanding hairs. Under-surface darker, tibiae rounded above and finely serrate. Length, 2.4 mm.

Life History.

Specimens of this insect were forwarded to Mr. W. F. Blandford by Mr. E. E. Green as causing injury to the cocoa-tree (*Trans. Ent. Soc. Lond.* pt. iv, 1898). The beetles tunnel into the wood to oviposit. The insect was first reported from Sumatra, where it is a pest of the tobacco.

Xyleborus fornicatus, Eichhoff.

REFERENCES.—Eichhoff, *Berl. Ent. Zeitschr.* xii, 151 (1868) ; Blandford, *Trans. Ent. Soc. Lond.* p. 213 (1896).

Habitat.—Ceylon.

Trees Attacked.—Tea (*Camellia theifolia*), Cocoa (*Theobroma cacao*) (E. E. Green).

Description.

Beetle.—Very small, oblong, rather shining, varying from pallid testaceous to pitchy fuscous, with long, sparse, erect setae. Front of head somewhat flattened, with an indistinct longitudinal elevation, shining, obsoletely punctate ; eyes small, narrow. Prothorax much broader than long, sides sub-parallel, apex very obtusely rounded, hind angles sub-rectangular, base transverse ; surface strongly convex from base to apex, somewhat flattened in front, apical half with very scattered granules, weaker behind, the basal half finely reticulate, feebly punctured at the sides only. Elytra as wide as and nearly a half longer than the prothorax, with gently curved sides narrowed behind and broadly rounded at the apex ; surface pulvinate, obliquely declivous and somewhat flattened from the anterior third, punctate at the base, with scattered weak punctures on the interstices ; declivity weakly striate, the interstices sub-convex, with elevate piliferous points. Antennae and legs light testaceous. Length, 1.4 mm.

This small *Xyleborus* has proved a pest of considerable importance in Ceylon, where it has caused destruction to tea and cocoa plants. Mr. E. E. Green, who has studied its attacks, reports that the beetles tunnel into the living branches of the bushes, eating out ramifying tunnels in the wood, having a diameter of 1.1 mm. to 1.2 mm. These tunnels are at times so numerous as to kill the infested branches.

Xyleborus bengalensis, Stebbing.

REFERENCES.—Stebbing (*Dryocoetes*), Undesr. Scolytid. Ind. Reg. *Ind. For. Mem.* Zool. Ser. i, pt. i, p. 12 (1906); Assam Sál Ins. Pests, *For. Bull.* no. 11, p. 38 (1907).

Habitat.—Assam.

Tree Attacked.—Sál (*Shorea robusta*). Goalpara Sál Forests.

Description.

Beetle.—Short, oblong, convex. Reddish brown. Head with fine transverse striae laterally beneath the eyes; front punctate. Prothorax but little longer than broad, base truncate, humeral angles sharp, not rounded; sides and apex rounded. Disk convex medianly, depressed anteriorly, flat posteriorly, granulose, the granulations fine, with the interspaces smooth and shining; the posterior half of disk is almost smooth, especially on sides; surface set with long golden-yellow hairs. Scutellum large, blunt-elliptical, very shining, smooth. Elytra broader than thorax at point of junction with latter and one-sixth as long, truncate at base, latter slightly sinuate medianly, humeral angles rounded, sides scarcely sinuate, slightly dilated apically, apex pointed medianly; surface shining, slightly convex basally and depressed before middle, and strongly declivous apically; basal area almost smooth, with longitudinal rows of faintly marked punctures; apical declivity slightly convex, set with rows of fine, rounded elevations, which form a continuation of the rows of faint punctures on the basal half, and with fine, sparse, yellow, spiny pubescence. Length, 2.8 mm. (Pl. lx, fig. 3.) The type on which the species was described is damaged. It is doubtful, therefore, whether the species will stand.

Life History.

This beetle infests the sál (*Shorea robusta*) in the Goalpara forests of Assam. The female beetle has been taken tunnelling into the sapwood of green newly felled trees in the middle of May. It was ascertained that the beetles will bore into the trees within a couple of months of their being felled.

Xyleborus major, Stebbing.

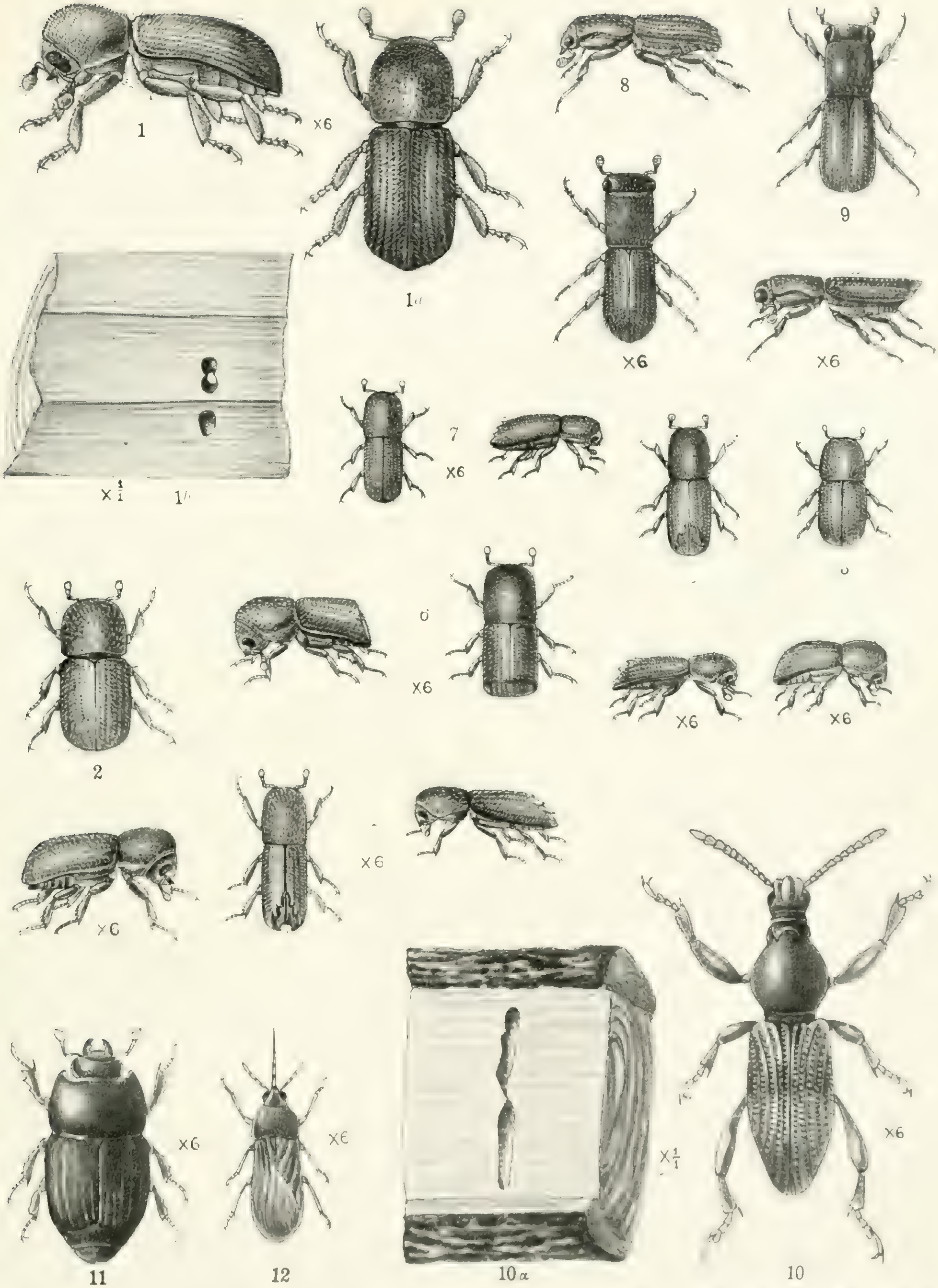
REFERENCES.—Stebbing (*Phloeosinus*), Undescr. Scolyt. of Ind. Regions, *Ind. For. Mem.* Zool. Ser. vol. i, pt. ii, 19 (1909); id. Assam Sál Insect Pests, *Ind. For. Bull.* no. 11, p. 36 (1907).

Habitat.—Assam.

Tree Attacked.—Sál (*Shorea robusta*). Goalpara Sál Forests.

Description.

Beetle.—Robust and thick; moderately shining. Head and prothorax reddish. Elytra dark reddish-brown. Head large, front smooth and dull medianly, at the sides of the eyes and posteriorly punctate, the punctures large and confluent, tailing off behind and above the eyes; a fringe of yellow hairs at base of mandibles. Prothorax but slightly broader than long, very convex, culminating in a prominent peak on centre of disk; covered with sharp spiky prominences and scales on anterior portion, these decreasing in size behind and laterally; the depressed



1, 1a, *Xyleborus major*, Steb.; 1b, borings in sál wood of *Xyleborus major*, Steb.; 2, *Dryocoetes minor*, Steb.; 3, *Xyleborus bengalensis*, Steb.; 4, 5, *Xyleborus fallax*, Eichh., ♀ and ♂ beetles; 6, *Xyleborus schlichii*, Steb.; 7, *Xyleborus perforans*, W.; 8, *Platypus curtus*, Chap.; 9, *Diapus quinquespinatus*, Chap.; 10, *Zemioses* sp.; 10a, borings of *Zemioses* sp. in sál wood; 11, *Platysoma?* sp.; 12, *Hemiptera*.

area posteriorly smooth, shining, and finely pitted. Sparsely clothed with long yellow hairs anteriorly. Elytra not wider than thorax, not quite twice as long, moderately convex, sides straight to apical declivity, thence rather sharply constricted to apex; surface dull with feebly impressed rows of small punctures, the sutural striae more defined apically; the declivity moderate, set with small spiky prominences and clothed with a sparse long yellow pubescence. Under-surface dark brown, abdominal segments punctate, with a spiny seta in each puncture. Antennae and legs brown, shining. Length, 5.4 mm. to 5.8 mm. Pl. lx, figs. 1 and 1*a*, shows this beetle, and fig. 1 *b* the borings in sál wood.

Larva.—Short, thick, white, but slightly curved, legless. Body corrugated. Length, 5.8 mm.

Pupa.—Short, thick, whitish yellow, having a resemblance to the beetle.

Life History.

The *Xyleborus*, which is the largest of the scolytid borers at present known as infesting the sál-tree, bores a single tunnel down through the bark into the sapwood. This is probably the work of the male. It goes in for about half an inch. At the end the insect hollows out a pairing-chamber. Two females are apparently fertilized here by the male, or possibly sometimes three. After pairing, each female tunnels away at an angle from the pairing-chamber, either to the right or left, or if there are three females the third will go directly downwards. In the gallery of a female carried to the right which was examined on 20 May I took out, about two inches down, two pupae and three nearly mature beetles (males and females). They were all in the one gallery, to which there were no offshoots, and had a diameter equal to that of the tunnel in which they closely fitted. As there were no offshoots to the egg-tunnel nor any indication of the grubs having lived upon wood, it is probable that they belong to the class of ambrosia feeders and live upon fungous growths lining the walls of the tunnels. The question arises, Are the pupae and nearly mature beetles found in the wood in the latter part of May those of the first generation of the year? I think this possible. Beetles were also found tunnelling into newly felled trees within four days of the latter being cut, evidently with the object of pairing and egg-laying. It is thus probable that there are at least two, if not more, generations in the year.

Damage Committed in the Forest.

The beetle itself bores down into living green wood of standing trees, which is a peculiar habit (pl. lx, fig. 1 *b*). It probably only infests sickly trees with stag-headed tops, but it is never found in the dead parts of the tree. Several green standing trees infested were examined. The dead tops invariably showed that they had been tunnelled into in previous years by the beetle. Below the dead parts near the junction of the old dead and the live green wood it will be found at work. The beetle ruins the timber of the tree when very numerous.

Xyleborus schlichii, Stebbing.

REFERENCE.—Assam Sál Ins. Pests (*Acanthotomicus truncatus*), *For. Bull.* no. 11, p. 40 (1907).

Habitat.—Assam.

Tree Attacked.—Sál (*Shorea robusta*). Goalpara, Assam.

Description.

Beetle.—Short, compact, with elytra abruptly truncate behind, the truncation being circular in section. Head and thorax reddish yellow, elytra dark ferruginous brown. Head smooth, shining, vertex covered with very fine reticulations, the front rugose with a few small prominences, a sparse fringe of longish hairs over base of mandibles. Thorax longer than broad, very convex in anterior half, depressed in posterior, sides rounded apically, posterior outer angles bluntly rounded, base truncate; surface set with scaly asperations, smallest apically, becoming larger and denser centrally, tailing away behind and on sides, where the scales are replaced by fine striations and reticulations; the posterior depressed area with very fine reticulations and scattered fine punctures. Scutellum small, rounded. Elytra as long as thorax, smooth, with irregularly impressed striae carrying a few very shallow punctures, the intervals shining smooth or dull, and set with very fine reticulations; apex abruptly truncate, the declivity being circular in section, impressed, with three vertical rows of rather large shallow punctures in each half and sharp teeth on the sutures, the sutural ones at the top of the declivity being most prominent; a few spiny hairs on declivity. Under-surface reddish yellow, set with yellow hairs on anterior portion. Abdominal segments punctate, legs and antennae yellow-brown, latter pubescent. Length, 3 mm. to 3.2 mm. Pl. lx, fig. 6, depicts a dorsal and side view of this beetle.

Life History.

This small *Xyleborus* was taken plentifully at Kachugaon in Goalpara in the latter part of May 1906. It tunnels down into the wood of fresh-felled or sickly standing trees, apparently laying its eggs deep down in the sapwood. The beetles were engaged in egg-laying during the latter half of May.

Xyleborus sp.

REFERENCE.—Stebbing (*Dolurgus*), Assam Sál Ins. Pests, *For. Bull.* no. 11, p. 38 (1907).

Habitat.—Assam.

Tree Attacked.—Sál (*Shorea robusta*). Goalpara Sál Forests.

Description.

Beetle.—Elongate, slender, reddish brown. Apical portions of elytra sharply constricted into blunt points, antennal club with two transverse bands of light yellow hairs. Thorax constricted behind and truncate anteriorly, truncation blackish and finely asperate; the disk shining and very finely punctate. Elytra constricted sharply to a point behind; basal portion red and finely punctate; the remainder becomes blacker in colour as apex is reached, the surface scaly and punctate and clothed with scattered yellow hairs. The curious constricted apices of the elytra are a marked characteristic of this insect. Length one-sixth of an inch.

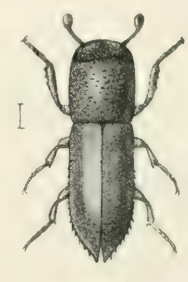


FIG. 369. *Xyleborus* sp. in sál wood in Assam.

The species remains undetermined, as only a single individual has been taken.

A specimen of this scolytid was found tunnelling down through the bark of the sál-tree felled in the Kachugaon Forest on 13 May. The beetle was taken on the 16th.

Xyleborus andrewesi, Blandford.

REFERENCE.—Blandford, *Trans. Ent. Soc.* p. 227 (1896).

Habitat.—North Coimbatore, Madras. Also taken in Belgaum by Andrewes.

Tree Attacked.—*Shorea talura.* Dhimbum, North Coimbatore.

Description.

Beetle.—Elongate, cylindrical, elytra constricted apically. Red-brown. Prothorax anteriorly and apical two-thirds of elytra darker to almost black. Prothorax slightly longer than wide, widest across middle, base straight, basal angles slightly truncate, apex strongly rounded; anterior two-fifths with rather close small transverse asperities, decreasing in size inwardly from apex, being replaced on rest of surface by fine shallow punctures, the apex with some sparse yellow setae. Elytra but slightly wider than prothorax at base, humeral angles oblique, sides constricted behind latter, thence slightly widened to apical third and thence sharply constricted; striate-punctate, the punctures of uniform size and placed rather close together; the interspaces smooth and bearing rows of long white stiff setae; the declivity oblique, occupying half the elytra, punctate and set with sharp tubercular asperities and long stiff spiny setae. Under-surface light red-brown, shining, punctate. Legs and antennae reddish yellow. Length, 1.8 mm.

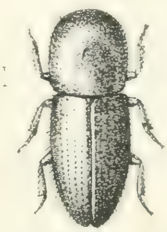


FIG. 370.
Xyleborus andrewesi, Blandford, in *Shorea talura.* North Coimbatore.

Life History.

The beetle is to be found egg-laying in the first week in August. On the bark of the tree a largish circular orifice is made of considerably greater diameter than the insect itself. This orifice reaches down to the sapwood. It is apparently commenced by one beetle, probably the male, and then enlarged subsequently by the other, the female. In the sapwood a short, vertical, funnel-shaped hole narrowing inwards is hollowed out, this being the pairing-chamber. After fertilization the female insect eats out a tunnel down into the sapwood, this tunnel taking off from the upper part of the funnel-shaped opening. The tunnel is straight, not winding, and goes down into the sapwood at an angle. The eggs appear to be laid at the bottom of the tunnel, but I have not ascertained exactly how they are laid, as in the only attacks observed the beetles were just commencing to oviposit, the egg-tunnel being still incomplete. The insects observed engaged in this operation were taken on 6 August 1902.

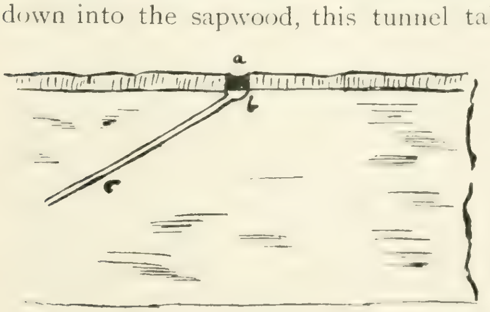


FIG. 371.—Tunnel of *Xyleborus andrewesi,* Blandford, in heart-wood of sál (*Shorea talura*). *a*, entrance-hole of ♂ and ♀ beetles; *b*, pairing-chamber; *c*, egg-tunnel in heart-wood.

The beetles oviposit in newly felled green timber, and, owing to their small size, the damage done is not great unless the beetles occur in large numbers. In the latter case the value of the wood would be seriously impaired.

Xyleborus parvulus, Eichhoff.

REFERENCE. Eichhoff, *Berl. Ent. Zeitschr.* vol. 12, p. 152 (1868).

Habitat.—Siwaliks, Northern India; South Malabar, Madras.

Trees Attacked. *Odina wodier:* Shajehanpur, Siwaliks; *Buchanania latifolia:* Karwapani, Dehra Dun; Unknown: Karimponga Plantation, Nilumbur.

Description.

Beetle.—Elongate, cylindrical. Red-brown, moderately shining; under-surface lighter, legs and antennae orange-brown. Head hidden by prothorax, punctate, front convex. Prothorax longer than wide, base truncate, sides straight, apex rounded; anterior third with large transverse asperities decreasing in size and giving place to reticulations medianly on disk; posterior half punctate, smooth; sides and apex with sparse long spiny setae. Scutellum large, heart-shaped, blackish brown. Elytra nearly half as long again as prothorax, scarcely wider than latter at base, slightly wider apically; strongly punctate, the punctures large, shallow, often becoming reticulate; the suture thickened and blackish; declivity rather sharp, with a black pointed tubercle near upper part and close to suture and a much smaller one laterally and higher up; punctate, with scattered stiff setae which are also present on sides of elytra. Under-surface punctate, tibiae dentate and spined. Length, 2 mm. to 2.3 mm.

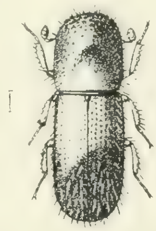


FIG. 372. *Xyleborus parvulus*, Eichhoff, in *Odina wodier*. Siwaliks.

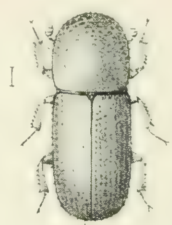


FIG. 373. *Xyleborus parvulus*, Eichhoff. Nilumbur, Malabar.

Life History.

This small scolytid oviposits in the dying timber of *Odina wodier*. At the beginning of December 1902 I took a number of the beetles from tunnels in the wood in which they were maturing. The trees in which they were found had been felled over in coppice fellings made between the previous January and March. I was able to ascertain the fact that the female lays several eggs at the bottom of the egg-tunnel, which is driven into the solid wood.

At the commencement of February 1906 a generation of this insect was found maturing in a standing tree of 2 ft. girth. The bark showed numerous shot-holes on the outside, and on removing it these holes were seen to penetrate the sapwood. An inspection showed that the tunnels in the sapwood were carried from varying distances inwards, but that the majority went down to the centre of the heart-wood. The upper part of the tunnel at its entrance into the sapwood was in most cases blocked by the dead body of the mother beetle. After completing the egg-tunnel in the wood and laying her eggs in it, she had retired up it and died near the entrance, thus effectually blocking it against intruders.

The egg-tunnel is carried as mentioned to near the centre of the tree by the female insect, and her eggs are laid at the bottom of it. On hatching

out the grubs appear to feed close together side by side, eating out a broad gallery or tunnel in the heart-wood whose direction is at right angles to the mother tunnel, the gallery taking off from the bottom of the mother tunnel. This broad gallery made by the larvae gradually increases in width with their growth. On reaching full size the grubs pupate *in situ*, and from the pupae the beetles gradually mature.

At the beginning of February these broad larval galleries each contained from twenty-five to thirty beetles in them just maturing or mature. This would indicate that each female lays at least twenty-five to thirty eggs.

The heart-wood of the tree examined contained a number of the broad larval galleries, from the narrower end of which the egg-tunnel took off at right angles, running up into the sapwood and bark.

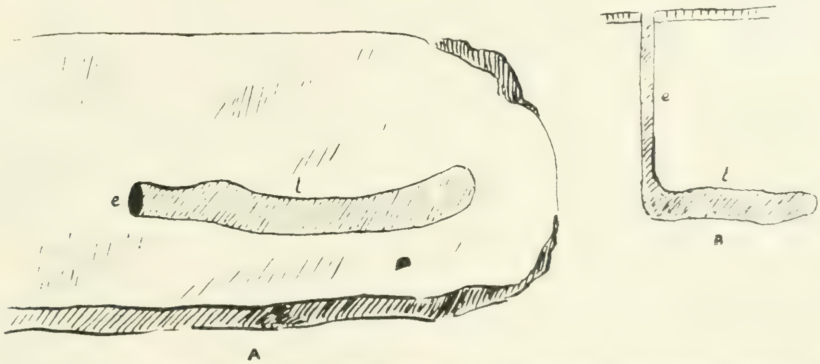


FIG. 374.—Egg-tunnel and larval gallery of *Xyleborus parvulus*, Eichhoff, in the wood of *Buchanania latifolia*. A, gallery made by larva in heart-wood (*l*), with base of egg-tunnel (*e*); B, egg-tunnel (*e*) and larval-gallery (*l*). Siwaliks, Northern India. (E. P. S.)

The egg-tunnel had evidently been eaten out and the eggs laid in the autumn of 1905, and the beetles arising from these eggs would issue about March or the beginning of April.

I have not yet ascertained how many generations the insect passes through in the year.

Damage Committed in the Forest.

The chief importance of this insect is in the damage it causes to the heart-wood of the tree. In the case examined the whole of the timber was worthless for anything save firewood. When the insect attacks a tree in the numbers here observable it also weakens it owing to the large number of holes riddling the cambium layer. The tree in question had died, and everything pointed to the fact that the beetles had killed it.

The *Buchanania* is of some importance in the Siwalik Forests, as it helps the sál-tree to cover the ground and thus prevent denudation and impoverishment of the soil.

I calculated that some 10,000 to 12,000 beetles at least were destroyed in the infested tree examined, which I had felled, cut up, and burnt.

I took an individual of this species which came into a bungalow at night, attracted by the light. The bungalow is situated in the Karimponga teak plantation, in the middle of the forest at the foot of the Ootacamund Hills. The insect was captured on 27 August 1902.

Xyleborus hagedorni, Stebbing, sp. nov.

REFERENCE.—This insect was submitted to Dr. Max Hagedorn, who kindly prepared drawings of the mouth parts, antennae, and fore leg. These I propose to publish with the description in the *Indian Forest Memoirs*. I have pleasure in naming the species after Dr. Hagedorn.

Habitat.—Tharrawaddy, Lower Burma.

Tree Attacked.—Teak (*Tectona grandis*). Kadin Bilin Forest, Tharrawaddy.

Description.

Beetle.—Elongate cylindrical, stout. Red-brown, shining, the prothorax anteriorly, elytra apically and laterally, darker in colour; rather densely pubescent except on disk of prothorax and on basal part of elytra. Front of head moderately convex, uniformly and finely punctate; a fringe of long yellowish setae over mouth; antennae reddish, club yellow. Prothorax with base straight, basal angles oblique, sides and apex strongly rounded; the anterior half strongly covered with large and close transverse asperities, largest and densest on anterior margin; these asperities stretch backwards on lateral surfaces to the basal angles; on disk the asperities are replaced by transverse striae which reach to the highest point of disk, which is situated behind the middle; rest of surface depressed to base, shining, and very finely and sparsely punctate. Scutellum transverse. Elytra more than half as long again as thorax, slightly wider at base, sides nearly straight, apex rounded; finely and regularly punctate, the punctures placed in rows and consisting of two kinds—round shallow ones in rows, and in the intervals a double row of smaller and deeper punctures, each containing one or more setae; a longitudinal shallow depression on either side of suture; declivity rather oblique, upper part punctate, lower portion with asperities; one or two longitudinal depressions down declivity, the surface rather densely covered with long spiny yellow hairs, densest on lowest portion. Under-surface darker in colour, finely punctate and pubescent. Legs red-brown, the tibiae long and dentate on anterior outer halves. Length, 2.8 mm. to 3.4 mm.

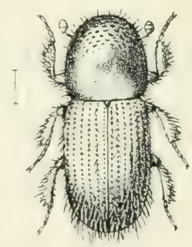


FIG. 375. *Xyleborus hagedorni*, Steb., sp. nov., in Teak. Lower Burma.

Life History.

This scolytid infests the leading shoots of young teak saplings. Whilst inspecting a young plantation in Tharrawaddy on 25 January 1905 I noticed a number of dead shoots, and inspection showed that they had each been tunnelled by an insect, the tunnel being carried up the centre of the shoot.

The female tunnels into the shoot, girdling it in part, and perhaps occasionally entirely. She then lays an egg near the centre above the partial girdle. On hatching, the grub eats out a gallery in the heart of the shoot, tunnelling upwards and killing the portion above where the egg was laid. On reaching full size it pupates at the top of the tunnel. When mature the beetle eats its way out of the shoot by a horizontal tunnel carried to the outside.

This insect must be looked upon as a serious pest in young plantations. The trees noted as infested in this manner averaged from five to six feet in height.

Xyleborus velatus, Sampson, sp. nov.

REFERENCE.—Sampson, *Ann. Mag. Nat. Hist.* ser. 8, vol. xii, p. 443 (1913).

Habitat.—Katha, Upper Burma; Salween River, Tenasserim.

Tree Attacked.—Teak (*Tectona grandis*). Mohnyin Forest, Katha; Wutgyi, Salween River.

Description.

Beetle.—Elongate, cylindrical. Red-brown, prothorax darker, almost black on sides; legs reddish yellow. Prothorax not much longer than wide, base straight, basal angles only slightly oblique, sides straight, apex bluntly rounded; anterior third with rather close transverse asperations, decreasing in size and changing to transverse striae to centre of disk; behind this smooth, rather shining, and finely punctate. Elytra nearly twice as long as prothorax, sides oblique, apex rounded, convex basally, sloping to apex; striate-punctate, the punctures large, circular, and shallow, the interspaces smooth and shining; elytral declivity rather abrupt, punctate, with several pointed tubercles and some long spiny setae. Under-surface piceous brown, abdominal segments red-brown, punctate. Length, 2.2 mm.

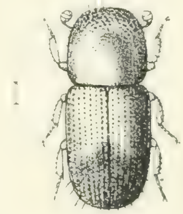


FIG. 376. *Xyleborus velatus*, Sampson, sp. nov., in Teak. Tenasserim.

Life History.

This is one of the teak-wood-boring scolytids. I took specimens of the beetle tunnelling into the timber of newly dead teak-trees in the 1896 teak plantation in the Mohnyin Forest towards the end of February 1905. The beetle tunnels straight down into the timber, laying its eggs at the bottom of its tunnel. I found the beetles ovipositing in the last week of February, probably laying the eggs of the first generation of the year.

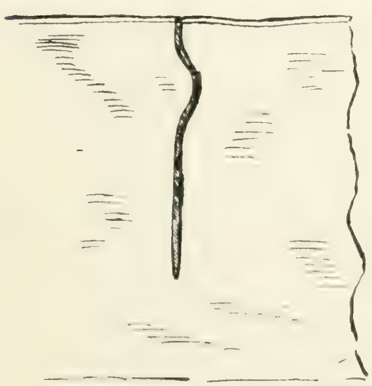


FIG. 377.—Egg-tunnel of *Xyleborus velatus*, Sampson, in teak wood. Katha, Salween River.

The beetles were infesting new dead standing trees, and also cut stumps. I also took some beetles which were apparently just maturing at the bottom of the egg-galleries from eggs laid the previous year (October–November).

The following month I again found this insect infesting teak, this time at Wutgyi on the Salween River in Tenasserim. My observations here showed that the beetles apparently invariably select newly dead trees for their operations. The female tunnels down through the bark and for a quarter to half an inch into the sapwood; the gallery then curves a little, and then resumes its original course straight into the heart-wood, the

eggs being laid at the end of the tunnel. At the end of the first week in March I took mature and maturing beetles at the bottom of the egg-galleries. Some appeared to have already left the tree, crawling up the egg-gallery made by their mother to escape.

Subsequently a generation of the beetles was found just maturing and leaving a tree, on 11 March 1905. The beetle apparently chooses the hardest portions of the timber to tunnel into for ovipositing purposes. The insects taken were maturing in tunnels driven into the hard wood of a green stump of a teak in the Shwegun plantation, and the egg-tunnels went alike through hard knots as through the knotless parts.

In the case examined the teak-stump was riddled with holes, and the numerous tunnels cut into contained for the most part quite mature or maturing beetles, the latter still light yellowish-brown in colour.

Relations to the Forest.

This small *Xyleborus* is of importance owing to the readiness with which it tunnels into the hardest teak timber and thus ruins its commercial value. The life history and abundance of the beetle requires careful attention on the part of Forest Officers in Burma.

Xyleborus noxius, Sampson, sp. nov.

REFERENCE.—Sampson, *Ann. Mag. Nat. Hist.* ser. 8, vol. xii, p. 445 (1913).

Habitat.—South Malabar; Salween River, Tenasserim.

Trees Attacked.—Teak (*Tectona grandis*): Nilumbur Teak Plantation, South Malabar; Yindiak (*Dalbergia cultrata*): Kowloon Island, Salween River; Pyinkadu (*Xylia dolabriformis*): Kamamaung, Salween River.

Description.

Beetle.—Elongate, cylindrical. Piceous brown; prothorax darker, almost black anteriorly. Head punctate, antennae yellowish brown, club yellow. Prothorax longer than wide, base straight, basal angles oblique, sides slightly rounded, apex strongly so; with prominent transverse asperities covering more than anterior two-thirds of the surface, decreasing in size to highest point of disk and extending laterally to base; rest smooth, shining, very finely longitudinally

FIG. 378. *Xyleborus noxius*, Samps., sp. nov., in *Dalbergia cultrata*. Salween River, Tenasserim.

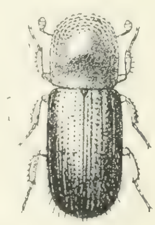


FIG. 379. *Xyleborus noxius*, Samps., in pyinkadu. Tenasserim.

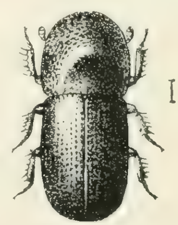


FIG. 380. *Xyleborus noxius*, Samps., in teak. Nilumbur, South Malabar.

striate. Scutellum round, large, smooth. Elytra about as wide as thorax at base, not half as long again; punctate, the punctures circular, shallow, rather large, the interspaces smooth,

with a very fine row of small punctures down them; declivity only moderately abrupt, striate-punctate, with a moderately dense covering of spiny setae, which are also present on disk and sides of elytra and on prothorax anteriorly. Under-surface light in colour, punctate, with a few sparse spiny setae. Legs brown, tibiae with four teeth on outer edge anteriorly and a terminal hook. Length, 2 mm. to 2.5 mm.

This insect is one of the common pin-hole borers of teak in Madras.

Life History.

I took the insect riddling teak poles in Nilumbur in August 1902, and saw the results of its work on other occasions in these forests. The female appeared to drive tunnels into hard timber, laying her eggs at the bottom of the tunnel.

Three years later I was able to make some further observations in Tenasserim on this insect, which is new to science.

A generation of beetles just mature and leaving a *Dalbergia cultrata* tree was taken on Kowloon Island, Salween River, on the 10th of March 1905. The insect evidently oviposits in nearly dead and newly dead trees. To oviposit the beetle tunnels down through the bark till it reaches the sapwood. On the outer surface of this latter a short transverse gallery about an inch in length is eaten out (fig. 381, *b*, *c*), and the female beetle is probably fertilized by the male here. From somewhere in this gallery the female beetle tunnels down into the wood, the tunnel curving at first and then going straight down into the wood for four to five inches (*d*). In several cases two holes took off from the transverse gallery, and the male may pair with more than one female. From the long tunnels in the wood I took two, three, and as many as four mature beetles which were obviously just mature and ready to leave the tree. The eggs are evidently laid at the bottom of the tunnel by the female beetle, at least four eggs being laid in each tunnel.

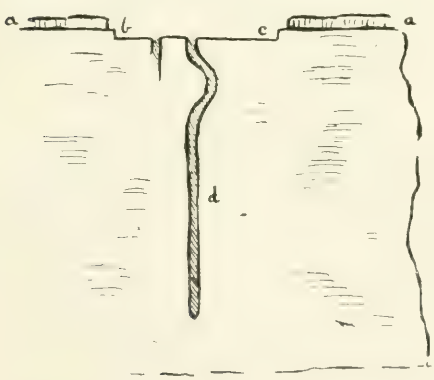


FIG. 381.
Egg-tunnel of *Xyleborus noxius*, Samps., in the wood of *Dalbergia cultrata*. *a*, bark; *b*, *c*, transverse gallery in outer sapwood; *d*, egg-gallery. Salween River, Tenasserim.

The infested tree examined was a large newly dead girdled standing yindiak, a large part of the lower portion of whose trunk was literally pitted with the entrance-holes of the insect. The attack in question was evidently just over, and the wood too dry for further attack, as I found none of the issuing generation of beetles tunnelling into the wood to oviposit.

This is also one of the pyinkadu scolytid wood-borers. I took this *Xyleborus* numerously in March in a large tree which had been felled in a clearing at Kamamaung, Salween River, some four to six weeks

previously. The beetles were just maturing from eggs laid to all appearance soon after the tree had been felled. If this is correct, the insect will probably be found to pass through several life-cycles in the year.

In the case of the galleries examined in the pyinkadu the female beetle bored vertically down into the sapwood for some distance, and then turned and carried her tunnel at right angles to its former direction. In this latter portion of the tunnel the eggs were laid, five or more in number. From one of these tunnels I took as many as five maturing beetles. When mature, the beetles simply crawl up the egg-gallery to escape from the tree, the mother-beetle dying at the end of her egg-gallery.

The egg-tunnels of this beetle were very numerous in the tree examined, and were taken deep down into the wood. Consequently the insect will undoubtedly prove one of considerable importance when this tree is exploited to a greater extent than at present.

Observations would seem to show that a generation appears on the wing some time in the latter half of January, and another in the first and second weeks in March. I took beetles on 8–11 March 1905.

In wood depots the insect may prove itself an annoying pest.

Anthocomus ? sp. (p. 183).—The beetle is predaceous upon this *Xyleborus* in Tenasserim, attacking it outside the tree.

Predaceous Insect.

Beetle.—Resembles in size and general appearance the insect shown in fig. 124. Head black. Prothorax canary-yellow. Elytra pale golden-yellow, the basal fifth purple, a purple blotch laterally, just above middle, not meeting suture, and another covering apical fifth. Head and prothorax together elongate, narrow, the former large, punctate. Prothorax but slightly wider than head, widest anteriorly, sides rounded; punctate. Elytra wider than prothorax at base, widest at level of posterior coxae, depressed behind, finely and rather closely punctate. Legs and antennae black. Length, 5.5 mm.

Life History.—I took a specimen of this small, active melyrid beetle on a launch on the Salween River. In order to ascertain whether its habits were predaceous, I placed it in a tube with the *Xyleborus* beetle described above and several other small bark beetles. The melyrid devoured the *Xyleborus*, picking it out from the other smaller beetles, rejecting only the harder outer parts of the scolytid.

Xyleborus improbus, Sampson, sp. nov.

REFERENCE.—Sampson, *Ann. Mag. Nat. Hist.* ser. 8, xii, 444 (1913).

Habitat.—Darjeeling, North-East Himalaya.

Tree Attacked.—Buk (*Quercus lamellosa*, Smith). Darjeeling (B. B. Osmaston).

Beetle.—Front black, sub-convex, just above the mouth are two coarsely punctured depressions separated by a slight longitudinal elevation; the posterior surface is finely reticulate; prothorax sub-globose, anteriorly asperate, transversely gibbous, posteriorly finely shagreened and sparsely granulate, with a very small cluster of piliferous punctures at the centre of the base. The scutellum black, transverse, and feebly punctate. Elytra equal in breadth to prothorax, about half as long again, sub-parallel, with apex somewhat bluntly rounded; striate-punctate, the punctures variolose in character; a double irregular row of punctures on the second interstice up to the commencement of the declivity, where there is a short, sharp spine, the declivous portion having a single row of minute punctures each furnished with a very long hair; the third interstice has two or three small spines on the declivity, which is depressed on each side of suture; the striae are sinuous outwards towards the apex. Length, 3 mm. (*Descr.* Sampson.)

Description.

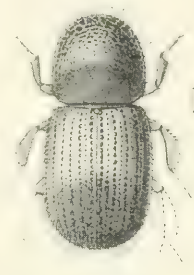


FIG. 382.
Xyleborus improbus, Sampson, sp. nov.
Darjeeling, Bengal.

I received some specimens of this *Xyleborus* from Mr. B. B. Osmaston in 1903. They were sent with the *Scolytoplatypus darjeelingi* beetles (p. 607), and were reported to tunnel into the wood of the oak *Quercus lamellosa* in the Darjeeling forests.

Xyleborus adumbratus, Blandford.

REFERENCES.—Blandford, *Trans. Ent. Soc. Lond.* 115 (1894); Osmaston, *Ind. For. Rec.* vol. i, pt. 3, p. 243.

Habitat.—Andaman Islands.

Tree Attacked.—Padauk (*Pterocarpus dalbergioides*). Andaman Islands (B. B. Osmaston).

Beetle.—Oblong, cylindrical. Black to piceous brown, thorax sometimes lighter than elytra, moderately shining. Head with front strongly punctate, with a more or less evident carina. Prothorax longer than wide, anterior portion covered with prominent asperities and long hairs, the central elevation prominent and transverse; basal half very shining, diffusely punctate. Elytra as wide as thorax, one half longer; sides parallel at base, slightly narrowed and rounded behind middle, apex feebly produced in middle, sinuate on either side; punctate, the declivity abrupt, punctate, the suture not elevated except at apex, the tubercles prominent and surface clearly punctate. Under-surface lighter in colour, abdomen somewhat darker. Length, 3 mm.

Description.

Life History.

This insect was discovered by Mr. B. B. Osmaston infesting padauk-logs stored in depots in the Andamans. Specimens were forwarded to me by Mr. Osmaston in 1908, with the report that the insects were riddling the logs. The insect was determined as a species of *Xyleborus*. In a note published on the Andamans Padauk Mr. Osmaston alluded to this insect as follows: "Padauk logs are usually stored in wet depots (fenced enclosures of

the sea). They may be safely kept in this way for a few months, but if subjected to prolonged immersion they are ruined by the marine worm (*Teredo navalis*). To avoid this an experiment was recently made in the dry storage of logs, which has, however, proved unsuccessful, the logs having been attacked by a small beetle which tunnels through the sapwood, penetrating more or less into the heart-wood. The damage done by the borings of this insect is not really very serious, as the tunnels do not as a rule penetrate more than about half an inch into the heart-wood; but the sapwood is riddled by the borings, and the heart-wood usually shows the holes on its surface, which detract from the appearance and market value of the log."

Xyleborus (Progenius) laeviusculus, Blandford.

REFERENCE.—Blandford, *Ann. Soc. Ent. Fr.* vol. 65, p. 21 (1896).

Habitat.—Andaman Islands. Also reported from Mysore (R. de la Perraudière).

Tree Attacked.—Padauk (*Pterocarpus dalbergioides*). Andaman Islands (B. B. Osmaston).

Beetle.—Elongate, somewhat shining, with a scattered short pubescence. Head and prothorax testaceous fuscous, blackish medianly; elytra piceous black, under-surface piceous fuscous, legs testaceous. Head with front closely but deeply punctate.

Description. Prothorax squarish, anterior angles rounded, posterior ones almost straight; sides and apex but slightly rounded, apical margin tuberculate. Scutellum rounded. Elytra just as wide and nearly twice as long as prothorax, base sub-transverse, humeral angles almost straight, anterior half of sides sub-parallel, thence obliquely incurved, apex strongly acuminate; punctate-striate, striae feeble, obsolete basally; punctures small, interstriae sub-convex and shining; declivity oblique, suture apically elevate: punctures obsolete, interstriae with minute rugosities; second spine on each side acute. Length, 3.4 mm.

So far as is at present known this insect would appear to have the same habits as *X. adumbratus* described above. Both species were identified by Colonel Winn Sampson.

XYLOTERUS.

This is the first record of a species of *Xyloterus* from India.

Xyloterus (Trypodendron) intermedius, Sampson, sp. nov.

REFERENCES.—Sampson, *Ann. Nat. Hist.* xii, 445 (1913); *Eccoptopterus sexspinosus*, Steb., *Depart. Notes*, i, 284 (1902).

Habitat. North-West Himalaya.

Tree Attacked.—Silver Fir (*Abies webbiana*). Baghi, Bashahr State.

Beetle.—♂ Brown. Head with front slightly concave and pubescent, coarsely punctured, two depressions just above the epistoma separated by a median longitudinal carina; eyes bipartite; antennal scape and funiculus, in most specimens, darker than the club, which is closely covered with pale pubescence, solid, obtusely rounded apically; prothorax transverse and depressed, constricted in front and without tubercles on the anterior margin, apex and sides clothed with longish hairs, the whole surface finely asperate. Scutellum bluntly triangular. Elytra not quite twice as long as prothorax, very slightly narrower than latter at its greatest width, sides sub-parallel, apex obtusely rounded, surface with long hairs, especially towards the sides and apex, finely lineate-punctate, interstices irregularly and closely punctate.

Description.

♀ Head brown, front sub-convex and pubescent, sculpture similar to that of male; prothorax sub-globose, apical margin bitituberculate and the anterior part strongly asperate, whilst the posterior portion is only slightly rugose. Scutellum similar to that of male. Elytra lineate-punctate, the punctures rather more distinct towards the base, interstices irregularly punctured. Under-side less hairy than in male. Length, ♂ 3.2 mm., ♀ 3.5 mm.

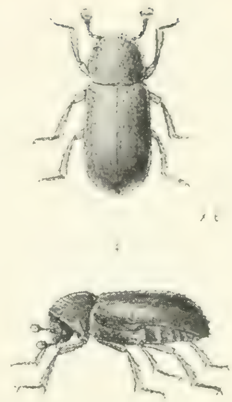


FIG. 383.
Xyloterus intermedius, Sampson, sp. nov., in silver fir. North-West Himalaya.

Life History.

The flight-time of this beetle is probably about the first fortnight in July at elevations of 8,000 ft. The female girdles the pendulous side branches of the silver fir, and oviposits in the portion above the girdle. I am unable to say whether the male beetle helps the female in this work. The girdle is made about a third of the length of the branch down from its upper extremity, the ringing being done just above the point of juncture of a small offshoot side branchlet. The egg or eggs are apparently laid generally just above the girdle. The object of the girdle is to kill the portion of the branch above, and thus provide a supply of dying wood for the larva to feed upon. The larva on hatching out bores up the branch, mining out a fairly deep gallery in the sapwood. This gallery may be straight or may curve about, but always goes up the branch. The wood consumed by the larva is passed out at its anal extremity, and fills up the part of the gallery it has already gnawed out. When full-fed the grub enlarges the top of the tunnel, forming a pupal chamber, and pupates in this. It was in these enlarged chambers at the head of the galleries that the beetles were obtained in July, the galleries below the chamber being invariably blocked up with the wood excreta of the larvae. In some cases I noticed that branches were ringed in several places at successive offshoot branchlets with the main branch. In each case a gallery was present above the girdle. Whether this was the work of the same beetle or of different ones I was not able to determine. It would seem, however, that only one egg is laid, or only one larva develops, above each girdle. In none of the galleries from which beetles were obtained was any opening to be seen on the outside of the branch, the girdle (usually partially or wholly encircled with resin) and the

dying or dead condition of the branch being the only external evidence of the beetle's work. Branches attacked by a previous generation of beetles showed, however, in the cases where the dead portion above the girdle had not already dropped off or been knocked off, a small round hole of exit communicating with the outside from the pupal chamber, and it is evident that the matured beetle leaves the branch by boring horizontally through the bark above it.

I am at present unable to state whether this beetle has more than one generation in the year. I found on 5 July 1901 two newly ringed branches, and it is probable that the beetle lays her eggs soon after issuing, about the middle of the month. The July insects may be the beetles of the first generation of the year laying the eggs of a second generation.

Relations to the Forest.

The damage done is to the side branches of the silver fir. The beetle rings these at a point generally about two-thirds to three-quarters up from where they leave the main trunk. The portions above the rings die, and the effect, whilst causing a certain loss of branches and consequently leaf-area to the tree, gives it a scraggy appearance, the ends of numbers of the branches being in a dead or dying state.

The power of the insect for harm will, however, be far greater if it attacks the leading shoots of seedlings, saplings, and young poles.

Protection and Remedies.

When attacks of this nature take place in nurseries, plantations, etc., a feasible plan of getting rid of the beetles is to collect carefully all the portions of the twigs and branches above the rings and burn them. If this operation is done carefully and at the proper time, i.e. when they contain larvae or pupae, it will stamp out the pest.

Sub-Family 4.—Mixtodentatae.

Edges of middle jaw fringed with pubescence and bristles. The sub-family contains the curious tribe Spongocerinae.

Tribe SPONGOCERINAE.

This tribe appears to link up the Scolytidae (Ipidae) with the Platypodidae. It includes the genus *Scolytoplatypus*, of which the greater number of the seventeen species known come from Japan and the Himalaya.

Scolytoplatypus himalayensis, Stebbing, sp. nov.

Habitat.—North-West Himalaya.

Tree Attacked.—Silver Fir (*Abies webbiana*). Chamba State, North-West Himalaya, 8,500 ft.

Beetle.—♂ Dull, head and thorax black, elytra dull rufous brown apically. Head with front deeply concave to eyes, very densely, finely, and uniformly punctate; antennal club pubescent, rest almost hairless. Thorax with apical margin evenly rounded with a median cleft, sides rounded and produced outwards medianly, thence constricted gently to basal angles which are slightly produced, base bisinuate, produced medianly; surface with a median line most prominent in basal portion and not reaching to anterior margin, punctate, the punctures rather large and shallow, the interspaces very finely punctate. Elytra with basal margin raised and bisinuate; striae deeply impressed, the two inner ones obsolete towards basal margin, the third not quite reaching the margin, the surface irregular with a few scattered punctures, the interstices broad, finely reticulate with irregularly transverse punctures, strongest apically; alternate interstices carinate from two-thirds up to apex, the surface of carinae irregularly punctate, ending in a fine sharp black spine with a few sparse yellow hairs beneath. Apical declivity light reddish brown with a very short sparse yellow pubescence. Under-surface black.

Description.

FIG. 384.

Scolytoplatypus himalayensis, Steb., sp. nov., in silver fir. North-West Himalaya.

♀ Head and elytra shining, red-brown, thorax black, dull. Head globose, shining and smooth on vertex, dull and finely and closely punctate on front and sides, a slight brush of hairs over mandibles. The median line less prominent, not extending beyond the median pore, which is moderate in size and filled with a short golden tuft of pubescence, the punctures similar to male on disk below the pore, but above it and laterally they merge into a fine dense reticulation. Elytra smooth, shining, with interstices similar throughout, broad, rather flat, uniformly and finely reticulate with a few scattered punctures. Under-surface black, the last two abdominal segments light yellow-brown. Length, ♂ 3.2 mm.; ♀ 4 mm.

The differences in the thorax are sufficiently distinct to distinguish the species from *mikado*, Blandford, and the head from *raja*, Blandford.

Life History.

This beetle matures and leaves the tree in the latter part of June at high elevations (8,000 to 9,000 ft. and over). In 1909 I was fortunate enough to discover it infesting a blown silver-fir pole which was still partly green. A few larvae and pupae were taken, but the insect was mostly in the mature-beetle stage, and some of the generation had already left the tree.

The male beetle tunnels into the tree through the bark, and on reaching the sapwood eats out a short gallery in the bast and wood, usually completely in the latter. This is the pairing-chamber, and a female enters to him here and is fertilized. After fertilization, the female tunnels down into the sapwood at an angle for about an inch, and then eats out a straight gallery parallel to the long axis of the tree. From this main gallery she gnaws out little offshoot tunnels at intervals on either side, from one-fourth to one-third of an inch in length. These little offshoot tunnels are usually from six to eight in number, and are made alternately on either side.

Occasionally, as shown in pl. lxi, they may all take off on one side. In these the eggs are laid. On hatching out, the grubs feed upon the sap on the walls of the tunnel, or on fungus outgrowths growing there. By the time the grubs are mature the walls of the offshoot tunnels are deep black in colour to a depth of one-twentieth of an inch.

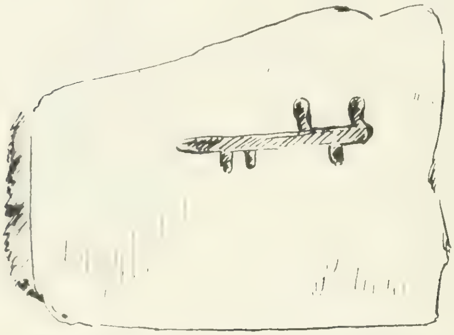


FIG. 385.—Egg-gallery of *Scolytoplatypus himalayensis*, Steb., in the wood of silver fir. Chamba, North-West Himalaya.

When full-fed the grubs pupate *in situ* in the offshoot tunnels, there being at least two eggs laid in each of the latter. On maturing, the beetles leave the tree by crawling out of the offshoot tunnel into the main gallery, and up this to the pairing-chamber, and then burrow out through the bark.

I found some of the beetles which had just matured in the blown pole tunnelling into a newly blown silver-fir close by, laying what were probably the first eggs of the year at this elevation (8,500 ft.). It is doubtful whether there is a second generation in the year, but it is possible that the June eggs may give rise to a generation of beetles by the following September.

Damage to Tree.

This scolytid is one of the most injurious insects I have yet found infesting the wood of the silver fir. The tree appears to be singularly free from a number of the bark and wood beetles which infest the other conifers of the Himalaya region to so serious an extent. It is impossible at present to say whether the insect is in any abundance in the Western Himalaya. I have only taken it on one occasion, but the wood of the tree in which I took it was riddled to a very serious extent, and useless for any save firewood purposes.

The genus is an interesting one, having been founded by Mr. W. F. H. Blandford on two specimens from the Himalaya (*S. raja*) (one in the British Museum and the other in the Brussels Museum), and four others obtained by Mr. G. Lewis in Japan. To the forester the importance and interest of the genus lies in the fact that it forms a connecting link between the Scolytidae and the Platypodidae, and that its habits are wood-boring, it thus resembling the *Xylebori* and platypids in this respect.

Bark and wood of the stem of a silver fir pole showing the egg tunnels in the wood made by *Scolyto-platypus himalayensis*, sp. nov., Stebbing. Chamba, North-West Himalaya, June 1909.

Scolytoplatypus brahma, Blandford.

REFERENCE.—Blandford, *Trans. Ent. Soc. Lond.* 425 (1898).

Habitat.—Chittagong Hill Tracts.

Tree Attacked.—Mahogany (*Swietenia mahogani*, Linn.). Kaptai.

Beetle.—♀ Resembles the Japanese *S. mikado* in form, but the elytra are relatively shorter, not more than one-third longer than the prothorax. Blackish-pitchy, dull, entirely covered with fine and extremely dense alutaceous reticulation.

Description.

Front minutely punctate, with a transverse subnitid impression over the mouth, the space between it and the black epistoma brown-testaceous; antennae brown-testaceous, the club infuscate, obovate-acuminate. Prothorax with the lateral and hind angles prominent and acute, median pore not large, oblong, surface with very close, confluent, longitudinal, strigose punctures, not deep. Elytra scarcely bisinuate at base, lighter along the suture and at the apex, closely shagreened with traces of striae, the punctures of which are not discernible; interstices from behind the middle with a faint median raised line, the first, third, and fifth on the declivity with a series of minute tubercles; declivity convex, with short, erect, yellowish pubescence. Under-side piceous, lighter in places, with coarse, shallow punctuation; anterior legs piceo-ferruginous, the middle and posterior legs brown-testaceous. Length, 3 mm.

Life History.

I can trace very little about the life history of this insect. Specimens were evidently sent to the Indian Museum by the Chittagong Divisional Forest Officer, presumably from Kaptai, where, amongst other exotics, there is a plantation of mahogany, the only one, I think, existing at that time in the district. They were said to be destructive to mahogany-trees in company with *Xyleborus gravidus* (p. 586). Although I examined the trees several times whilst I held charge of the Chittagong Division, I was never fortunate enough to secure any individuals of this insect. The specimen or specimens sent to the Indian Museum were forwarded with a collection of Bostrychidae to M. Lesne at the Paris Museum, and by him sent to Mr. Blandford.

Scolytoplatypus darjeelingi, Stebbing, sp. nov.

Habitat.—Darjeeling, East Himalaya.

Tree Attacked.—Búk (*Quercus lamellosa*, Smith). B. B. Osmaston. Darjeeling.

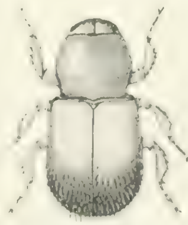


FIG. 386.
Scolytoplatypus darjeelingi, Steb., sp. nov., in oak. Darjeeling.

Beetle.—Oblong, cylindrical, moderately shining. Head and thorax dark brown, elytra chestnut yellow, the apical portion dark brown, darker in ♀ and pubescent in both.

Description.

Head and thorax with small rather scattered well-defined punctures, the surface between very finely and closely reticulate; the elytra wider than thorax, not one and a half times as long, with basal margin but slightly elevate, smooth, feebly striate and punctate, the punctures in rows, with the intervals smooth and very finely punctate, the declivity darker-coloured, striae stronger, rugose, and tuberculate; the apical third pubescent, the pubescence closer and shorter on declivity.

♂ Head concave on front, with two long brushes of reddish hair over eyes curling down on to front. Prothorax wider than long, base straight, sides much rounded, the anterior margin emarginate, the surface covered with a few sparse hairs. Elytra with sides slightly rounded to near apex, thence constricted slightly, the apex bluntly obtuse; surface somewhat flattened basally, moderately shining, the apical third dark brown, the colour gradually darkening to apex; the diskal striae feeble but visible from base, absent on lateral areas, more prominent on apical declivity, the surface of which is rougher, the intervals rugose and tuberculate; the pubescence fairly dense on declivity.

♀ Head without central brush of hair on front, with a longitudinal rather feeble median line, convex, with scattered fine punctures becoming larger on vertex, the surface between very finely reticulate. Prothorax with anterior margin nearly straight, base slightly bisinuate, sides rounded anteriorly, produced into a blunt point medianly, thence emarginate, the posterior outer angles bluntly obtuse; the diskal pore elliptical in shape, filled with a dense yellow pubescence. Elytral striae very feeble, the suture brown throughout, the rest of colouring darker than in ♂; the striae and rugosities on declivity not so prominent as in ♂ and the pubescence less dense. Length, ♂ 2.8 mm., ♀ 3.1 mm.

Life History.

This beetle was first discovered in 1903, tunnelling into the timber of oak-wood in Darjeeling, by Mr. B. B. Osmaston, in charge at the time of the Darjeeling forests. The beetle was cut out of the galleries in the wood of the tree, but no further information on its life history was obtainable.

Undetermined Scolytidae.

Hylesinus ? or **Dryocoetes** ? sp.

Habitat.—Siwaliks, North India.

Tree Attacked.—Sandan (*Ougeinia dalbergioides*). Sabbhawala, Siwaliks.

Beetle.—I have taken only immature dead specimens in tunnels in the wood of the tree. These were light yellowish brown to dark brown, but dried up and undeterminable.

Life History.

Towards the end of April I obtained a number of dead beetles from the inner bark and sapwood of a dead *Ougeinia dalbergioides*. The female tunnels through the bark of the tree to oviposit. On reaching the sapwood she eats out in this and the bast a transverse gallery, i.e. at right angles to the long axis of the tree, laying her eggs on either side. On hatching, the grubs eat out galleries at right angles to the female tunnel, the larval galleries keeping a straight course with but little serpentining. All the galleries groove deeply into the sapwood.

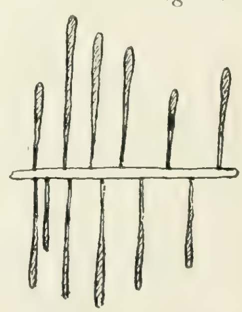


Fig. 387.—Egg and larval galleries of *Hylesinus* ? or *Dryocoetes* ? sp. in the sapwood of *Ougeinia dalbergioides*. Siwaliks. (E. P. S.)

Observations seemed to indicate that the beetles oviposit in trees which have died and lost a portion of their sap, but further investigation is required to substantiate this point.

Xyleborus ? sp.

Habitat.—Tezpur, Assam.

Tree Attacked.—Semul (*Bombax malabaricum*). Tezpur.

Life History. This small scolytid is one of the semul-wood borers, and is a pest of considerable importance. Soon after the trees are felled this beetle tunnels down into the wood to oviposit, the egg-tunnels being carried in to a varying distance, sometimes reaching deep down in the wood. The eggs are laid near the bottom of the tunnel in small offshoot galleries. The grubs would seem to be ambrosia feeders, since they do no wood-tunnelling themselves. They pupate in these small galleries, and the beetles, when mature, crawl into the main egg-gallery and up this, and so escape from the tree. A generation of the beetles evidently appears on the wing in the semul areas in January or February, and tunnels into newly felled trees to lay its eggs. These trees are subsequently sawn up into planks in the sawmills for tea-boxes, probably during the following hot weather and rains, and the wood is then found to be riddled with the minute galleries of this beetle. At times the wood is so full of the galleries that the planks are seriously weakened thereby, and the portions so infested have to be discarded.

At the commencement of April 1906 I visited a sawmill near Tezpur, where semul-logs were being cut into planks and small boards for the preparation of tea-boxes. As soon as cut, the small boards are stood up against one another in small heaps to dry, as the wood is still full of sap. I examined a number of these small planks, and found many of them scored with the tiny galleries of this insect. From many of these galleries I took live beetles, some maturing and others apparently tunnelling into the fresh wood to lay eggs.

From its method of attack in the semul, this small scolytid is a pest of some importance; and in sawmills it would be well to burn all seriously infested planks, and to burn all fresh refuse material in which otherwise the beetle might be likely to oviposit, and so breed out fresh broods to carry on the infestation of fresh timber as it arrives in the mill.

Undetermined Scolytid.

Habitat.—Tharrawaddy, Lower Burma.

Tree Attacked.—*Adina* (*Nauclea*) *sessilifolia*. Konbilin Forest, Tharrawaddy.

Life History. I took some specimens of a minute scolytid tunnelling into a green stump of *Adina sessilifolia*, in company with *Platypus suffodiens* (p. 621), in the last week of January 1905. The tunnels of the scolytid are easily distinguishable from those of the platypids, owing to their much smaller diameter. The beetles

were ovipositing at the time of capture, the first beetles to appear in the year laying the eggs of the first generation. The egg-tunnel is carried down more or less straight into the wood of the tree, the eggs being laid at the bottom of it. I took no larvae in the egg-tunnels, most of which appeared to be yet incomplete.

Undetermined Scolytid.

Habitat.—Ataran River, Tenasserim.

Tree Attacked.—*Terminalia belerica.* Natchoung, Ataran River.

A minute scolytid was cut out of the sapwood of a large, felled, dead *Terminalia belerica* tree on 17 March 1905. I know nothing further about its life history.

CHAPTER XXII.

RHYNCHOPHORA (*continued*)—Family PLATYPODIDAE.

THE beetles of this family are easily distinguishable from the Scolytidae (Ipidae) owing to their more elongated form with parallel sides, the large exserted head, and the long legs with slender five-jointed tarsi. They were originally classified as a sub-family of the Scolytidae. From a study of the habits and the considerable difference in the structure of the family I have long held the opinion that they should be classed as a true family. In his recent work for the *Genera Insectorum* Dr. Hagedorn confirms this opinion in that he omits the Platypodidae from his family Ipidae. Colonel Winn Sampson, who has kindly described some of the new species, also treats the Platypodidae as a distinct family.

So far as present observations have been conducted, the Platypodidae would appear to be entirely wood-borers. The Indian species known all tunnel into the wood of trees to oviposit, the eggs being deposited at the bottom of the tunnel either in the sapwood or heart-wood of the tree. The beetles may be considered as semi-diurnal, since they are often to be found tunnelling into the tree in the daytime, fly well in sunlight, and have a habit of coming up to the orifice of their tunnel in the bark and protruding the head, possibly to obtain fresher air. They remain alive for some time after the eggs are laid and have hatched out, and often die in the upper part of the tunnel in the portion made in the bark, thus blocking the tunnel to the entry of predaceous foes. The larvae resemble in habits those of the scolytid wood-borers who are "ambrosia" feeders, as they invariably appear to feed upon the sap in the walls of the egg-tunnel or on fungous growths growing in this sap.

The family appears to have a wide distribution throughout India and Burma, both in the mountains and plains, and probably includes a considerable number of species. In my book on *Injurious Insects of Indian Forests*, published in 1899, I could only record one species of this family, reported as infesting oak-trees in the Himalaya, as a forest pest, viz., *Diapus impressus*, Janson. In this chapter I deal with nineteen species, of which eight are new to science, which oviposit in timber trees in different parts of the country and about whose life histories some data have been collected. The family would appear to be one of economic importance in the tropical and sub-tropical forests.

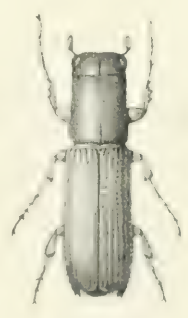


FIG. 388. *Crossotarsus coniferae*, Steb., in deodar. Western Himalaya.

The beetle is easily recognized by its elongate shape, which is quite unlike that of a scolytid. The head is exserted and free, and wider than the thorax; the eyes are round and prominent; the antennae are elbowed and short, placed between the base of mandibles and the eyes; the funiculus is very short and four-jointed, with a large and solid club. The prothorax is sub-cylindrical, with grooves at the sides in which the legs can be placed. The legs are elongate, slender, the femora and tibiae compressed; the coxae are large; the tibiae short, the front ones with fine oblique parallel lines on their outer surfaces; tarsi long, slender, weak, five-jointed, the first joint longer than all the others together. (Cf. fig. 388.)

Beetle.

The colour of the beetles is usually light or dark brown or nearly black or yellow in parts, the surface often shining. The elytra at times terminate in a calliper arrangement.

The grubs are white or whitish yellow in colour, elongate and straight, seldom being at all curved. The head is prominent and usually yellow, the body tapering gradually posteriorly, the corrugations being less well marked than in the Scolytidae (fig. 396).

Larva.

The pupa is elongate, narrow, white, and easily distinguishable from the scolytid pupa.

The family contains Indian representatives, who commit a considerable amount of damage to the timber of various species of forest trees. Perhaps the best known instance of this is the *Platypus* (*P. biformis*) of the *Pinus longifolia*, which has been reported as committing serious damage to the timber in Kumaun. In this part of the Himalaya it is known as "ghoon," a common name in India for the small wood-boring bostrychids of bamboos (*Dinoderus*). Investigations have shown that the "ghoon" of Kumaun is a *Platypus*. Other species in the Himalaya tunnel in a similar manner into the timber of deodar, spruce, and blue pine. In these cases and in several others investigated in Burma and elsewhere, the insects would appear to infest only the timber of freshly felled trees or that of dying trees standing in the forest. They will not attack dry timber. This is understandable when it is remembered that the larvae require that the walls of the egg-tunnel made by the beetle should be sappy, and thus capable of affording them the sustenance they require. The larvae as they develop stand, so to speak, one over the other in the tunnel, as no offshoot tunnels are eaten out by the mother, and appear to move up it as they grow in size, or shift about up and down as one or other part becomes eaten out. The grubs when full-fed change into pupae in the tunnel, and as the beetles mature (the upper ones maturing first) they crawl up the tunnel and escape, the first usually eating out an exit-hole through the bark.

Habits and Damage done by the Family.

Some species pass through two or more life-cycles in the year.

In the plains species have been taken infesting the sál, pyinkadu, *Terminalia*, *Nauclea sessiliflora*, *Meluisa*, *Pithecolobium*, *Alstonia*, *Wendlandia*, *Dalbergia*.

Classification.

Chapuis, in his *Monographe des Platypides*, divides the family (which he treats as a sub-family) into nine genera: *Crossotarsus*, *Platypus*, *Tesserocerus*, *Spathidicerus*, *Periommatus*, *Symmerus*, *Mitosoma*, *Cenocephalus*, and *Diapus*.

Of these three only are known at present to contain species of importance in the forests, i.e. *Crossotarsus*, *Platypus*, and *Diapus*.

Crossotarsus.—Head as wide as the prothorax, often concave and carinate in ♂. Maxillary palpi membranous, depressed. Mentum in ♂ with base coarctate. Mandibles convex on outer and concave on inner face, with a tooth below summit. Abdomen often appears vertical (resembling genus *Scolytus*), the posterior pair of legs appearing to be placed at the end of the body and far apart from the two anterior pairs, which are close together. Most of the pygidium is exposed.

Platypus.—Head as wide as thorax in ♂, a little less in ♀. Maxillary palpi as in *Crossotarsus*. Mentum in ♂ with base dilated or linear; mandibles short, robust, armed with two teeth on inner face; pygidium covered up in both sexes; apex of elytra varies in sexes.

Diapus.—Head wider than thorax, prolonged into a short rostrum. Maxillary palpi coriaceous, cylindrical. Mandibles often with an appendage. Front coxae far apart.

CROSSOTARSUS.

Crossotarsus coniferae, Stebbing.

(The Deodar Wood-boring Platypid.)

REFERENCES.—Stebbing, *Depart. Notes*, i, p. 411; id. *Crossotarsus piceae*, p. 413; *Ind. For. Memoirs*, For. Zool. Ser. ii, pt. i, 66 (1911).

Habitat.—North-West Himalaya.

Trees Attacked.—Deodar (*Cedrus deodara*), Spruce (*Picea morinda*). Tehri Garhwal, Jaunsar, Chamba.

Description.

Beetle.—Elongate, narrow, red-brown, shining; head nearly black. In the female the head is large with a transverse median line and two longitudinal depressions behind it on the vertex. Prothorax smooth, shining, with close wavy transverse striae, punctate posteriorly. Elytra broad, slightly wider in front than behind, striate-punctate, striae less defined medianly, truncate, apex terminating in a calliper-like process, the points much incurved, the truncate portion clothed with stiff yellow hairs. Ventral surface shining, abdominal segments concave, black. Legs yellowish brown. In the male the head is smaller, the transverse line being absent; the elytra are narrower and parallel, the terminal hooks shorter and only slightly curved inwards; abdomen not concave. Length, 4 mm. to 4.7 mm. Pl. lxii shows the male and female beetles.

Egg.—Ovate, elliptical, white, semi-translucent. Resembles a hen's egg *en miniature*. Length, 0.75 mm.

Larva (Young Stage).—Elongate, straight, white; thickest anteriorly, tapering posteriorly, head pale yellow. Length, 1 mm.

The mature beetle is to be found boring into fresh deodar wood towards the end of June at elevations of from 6,000 ft. to 7,000 ft.

Life History. The beetle bores down through the bark, making a cylindrical tunnel straight into the sapwood, this portion of the tunnel being either carried vertically downwards (in case of felled trees) or at an angle, perhaps more often the latter. When she has got down from half an inch to an inch into the sapwood the female is joined by a male beetle. This latter may have entered by crawling down the female tunnel, or he may bore a separate tunnel to intersect the female tunnel in the sapwood. Pairing takes place here. From this point the female subsequently takes her tunnel for an inch or so at an angle to the previous direction, and then zigzags in another direction until she has attained the required distance down into the wood. She then turns and eats out the remaining portion or branch of the tunnel in a direction usually more or less parallel to the outer bark, and at right angles to the long axis of the tree. This part of the tunnel is about 2 in. in length, is quite straight, and has no enlargement at the bottom (pl. lxii). Close to the end she deposits her first eggs. The number of eggs laid altogether by the beetle has not yet been ascertained, but in 1909 I found a little mass of four freshly laid eggs adhering together near the bottom of the tunnel with the female beetle a little higher up. The eggs are not stuck together by any adhesive matter, for the ones taken were found to be quite separate and easily parted on drying.

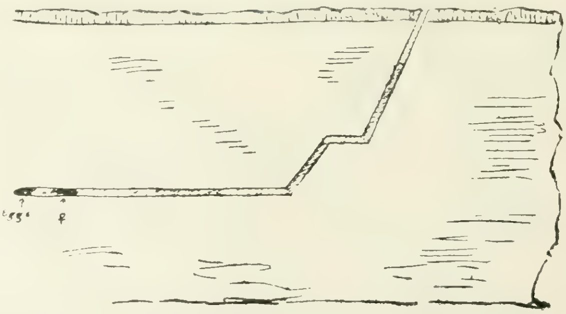


FIG. 389.—Egg-tunnel (diagrammatic) with eggs and female beetle of *Crossotarsus coniferae*, Steb., in deodar wood. Chamba, N.W. Himalaya. (E. P. S.)

Only a few young larvae have as yet been taken in these tunnels. They do not feed upon the wood, but probably belong to the so-termed "ambrosia" beetles, feeding upon fungous matters, either growths on the walls of the tunnel from the fresh sap which exudes down the walls, or perhaps induced there by the beetle itself, at any rate at first during the young stages of growth of the larvae. That this latter may be the case the habit of the beetle in remaining alive in the tunnel and moving up and down it during a considerable portion of the period required by the larvae in reaching full growth would seem to support. On the other hand, the wet sappy state in which the walls of the lower or inner part of the tunnel are always to be found, and the depth to which the female takes the portion of the tunnel in which she lays her eggs, where the walls remain moist for a period sufficiently long to enable the grubs to reach their full growth, would

seem to indicate that the material upon which the larvae feed is purely a growth of sap origin, and that the reason for the beetle remaining alive is to be sought rather in the protection she affords to the eggs and larvae when hatched out by blocking her tunnel against the entrance of predaceous insects and their grubs (in a manner similar to that of *Scolytus major* and *S. minor*), than in any attempt on her part to provide food for her offspring.

The female gallery is never carried into the hard rings of the heart-wood, though it reaches down to them, and may have penetrated the tree to a depth of from 6 in. to 12 in. or more when the sapwood is very thick. The insect burrows into the tree in an indiscriminate manner, the thickest end of the butt of trees, 6 ft. in diameter, being attacked equally with the top end of the stem and the thickest of the branches. It will only infest, however, deodar-trees with absolutely fresh sapwood, and so far as present observations go it appears only to bore in through the fresh bark and will not attack barked logs.

The beetles to be found at the end of June are laying the eggs of the second generation of the year.

A third generation of beetles have been taken in October laying eggs.

This *Crossotarsus* is more active than the ordinary platypids, and it walks at a comparatively good pace when outside its tunnel. It is active in daylight, and tunnels into a log on the ground as much on the side on which the sun impinges as into the parts in shade.

I first took this insect in Jaunsar and Tehri Garhwal in 1902, and have since found it numerously in newly felled green deodar logs in Chamba. It is probably distributed throughout the deodar tracts of the North-West Himalaya.

In June 1902 I cut some dead specimens of this platypid from the wood of a large girdled dead spruce in Tehri Garhwal. I could find no living beetles that year. Towards the end of June 1909 I discovered the beetle on the wing at Kainthli in Chamba. The beetles were tunnelling through the thick bark of a dead spruce, felled four months previously, to oviposit. This tree was in a drier state than I have ever found the insect in in deodar. The spruce beetles were observed to be pairing, the female entering by the same hole as the male, or *vice versâ*, the insects pairing in the outer sapwood. The female then carries the tunnel in the sap-wood in a series of zigzag curves parallel to the circumference of the tree, and about two inches in. The tunnel then turns, and goes zigzagging down into the wood. There are no offshoots to the tunnel, the latter ending

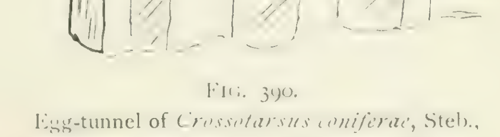


FIG. 390.
Egg-tunnel of *Crossotarsus coniferae*, Steb., in spruce. Chamba, N.W. Himalaya. (E. P. S.)

quite simply with no enlargement. At the bottom of one traced to its end, four newly laid translucent eggs were discovered. Just above the eggs in the tube was a dead female beetle. I was unable, unfortunately, to determine whether the beetle had died naturally, or had been killed whilst we were cutting open the tunnel. It is a fact worthy of note, however, that a day or two before I discovered four eggs only at the bottom of a tunnel in deodar with a living female beetle just above them. Whether four eggs is the total number laid by this platypid I am unable to say, but the number of eggs laid in the tunnel is almost certainly small in the case of these Himalayan insects. Those in the hot and moist semi-tropical forests of the country lay a larger number, as is seen in the case of the Assam sál platypids.

Damage Committed in the Forest.

When numerous this platypid must be considered a pest of considerable importance to the timber of the tree, since a badly attacked log shows numerous shot-holes on the outside of the sapwood, sometimes to such an extent that it is obvious that its strength and durability are greatly undermined.

The insect burrows into trees of all ages, and, failing a supply of felled or sickly trees or snow- or wind-breaks, it has been found to attack green standing trees in the forest.

Protection and Remedial Measures.

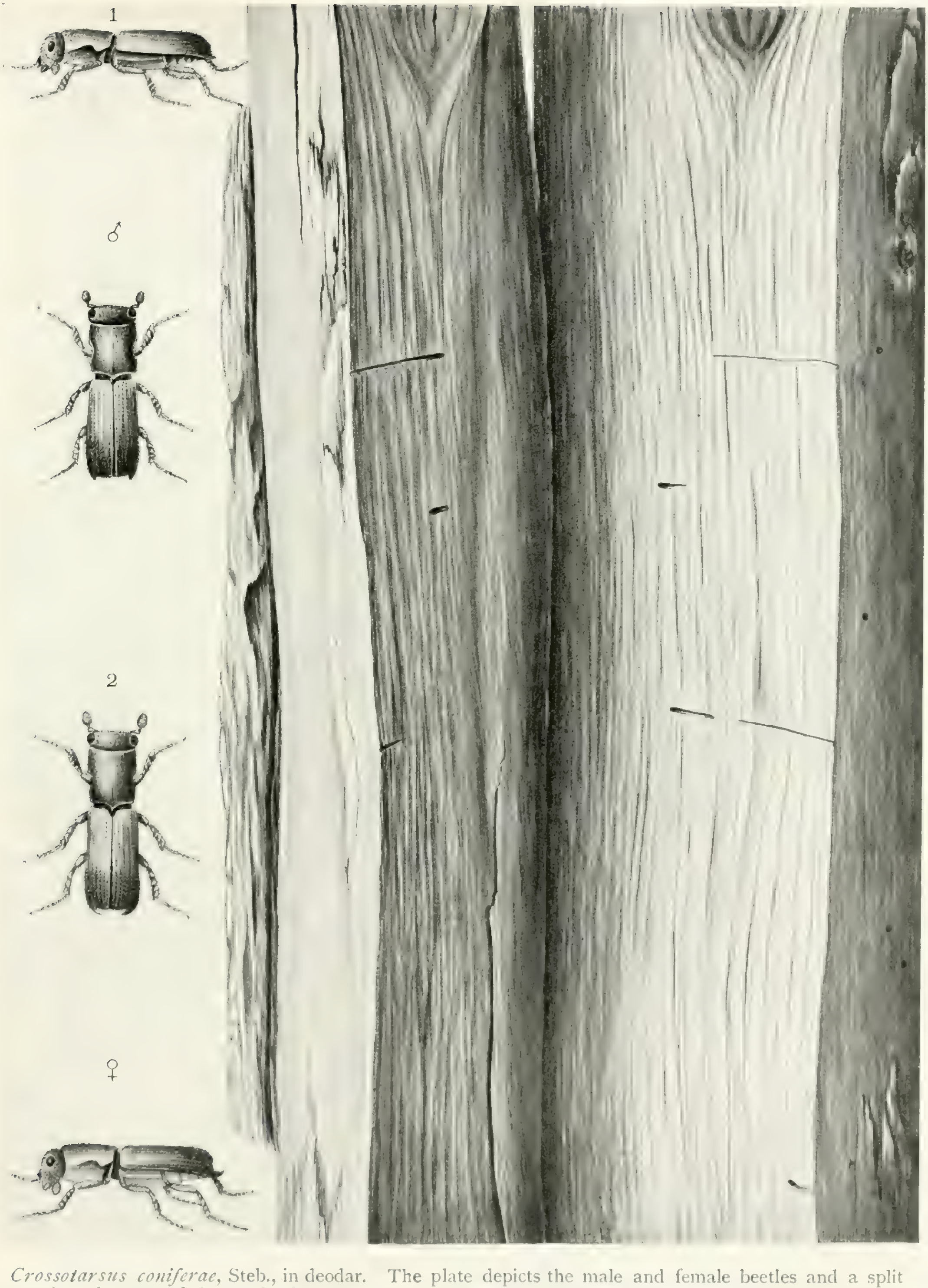
An obvious method of preventing this beetle increasing in a forest is to remove or bark all sickly and wind-thrown trees or snow-breaks, and, more important still, to *bark* all trees as soon as felled for sale purposes.

It is essential that this operation be undertaken as soon as the tree is down and has been logged, since once the beetle has got through the bark into the sapwood the removal of the bark will in no way affect it. In fact, it is likely to increase the injury to the timber, since it is probable that the female will carry her tunnel deeper down into the wood to escape the heat of the sun and the consequent more rapid drying of the outer sapwood which the removal of the bark will ensure.

The beetle attacks trees in swarms, so that a few days are sufficient for the insects to have penetrated an unbarked log throughout its entire length, and the damage to the timber will then be irremediable, since it must be remembered that this damage is entirely the work of the beetle, and is carried out within a period of from ten days to a fortnight.

Predaceous Insect.

Thanasimus himalayensis, Stebbing.—In Jaunsar and Chamba I noted that this predaceous clerid (described on p. 508) feeds upon this *Crossotarsus* in the imago stage. I do not know whether the larvae crawl down the tunnels in the wood to attack the platypid grubs. The beetle catches the platypus insect on the bark of the tree whilst it is searching for a spot at which to tunnel in, or whilst engaged in the preliminary stages of tunnelling.



Crossotarsus coniferae, Steb., in deodar. The plate depicts the male and female beetles and a split section of a part of the trunk of a tree showing the egg-tunnels in the wood. North-West Himalaya.

Crossotarsus saundersi, Chap.

REFERENCE.—Chapuis, *Mongr. des Platypides*, 80 (1866).

Habitat.—Siwaliks, North India. Also reported from Borneo (*Coll.* Wallace).

Tree Attacked.—Sál (*Shorea robusta*). The Dun Sál Forests, Siwaliks.

FIG. 391. *Crossotarsus saundersi*, Chap. Siwaliks, N. India.

Description.

Beetle.—Robust, shining, ferruginous brown, head and apical third of elytra nearly black. ♂ Front of head rugose-punctate, vertex punctate with a longitudinal raised median line. Scape of antenna nearly twice as long as broad. Prothorax oblong, with a short median furrow, not well defined, finely punctate, densest anteriorly. Elytra very lightly punctate-striate, apical portion clothed with a short stiff pubescence; declivity vertical, triangular, flat, and granulose. Abdominal segments finely punctate, coarsely pubescent. Length, $3\frac{3}{4}$ mm. to 4 mm. ♀ Front slightly impressed between the eyes, punctate-rugose, with a narrow smooth interrupted median carina, with strong coarse hairs. Prothorax with the median furrow confined to the posterior third, punctate, densest in front. Elytra punctate-striate, with a few deeply impressed short striae near the base; intervals finely and sparsely punctate, constricting in the posterior third, becoming narrow and carinate on the declivity, the carina tubercular. Apical margin of elytra strongly emarginate, the outer lateral angles projecting and sharp, with a sharp tooth placed inwardly. Abdominal segments flat, with a few deep piliferous pits; last segment deeply concave and densely punctate. Length, $3\frac{1}{2}$ mm. to $3\frac{3}{4}$ mm.

Life History.

This platypid infests newly felled sál-trees in the Dun sál areas in the Siwaliks. The beetle tunnels down into the wood to oviposit. About the middle of September I had some green sál-trees felled in three different years, and on each occasion this beetle was found boring down into the inner sapwood within a fortnight of the trees being felled. The insect would thus appear to resemble the deodar platypid in requiring fresh sappy wood for its operations. The tunnel is carried at an angle or in zigzags down into the wood, the eggs being laid at the bottom of it.

Crossotarsus fairmairei, Chap.

REFERENCE.—Chapuis, *Mongr. Platyp.* 79 (1866).

Habitat.—Jaunsar, North-West Himalaya.

Tree Attacked.—Blue Pine (*Pinus excelsa*).

Description.

Beetle.—Elongate, parallel, large and stout. Moderately shining, ferruginous brown, darker on head and apical half of elytra. Head smooth and finely punctate on front, more coarsely so on vertex. Prothorax square, strongly and finely punctate with scattered larger punctures, a narrow longitudinal median channel on basal third; elytra punctate-striate, striae most prominent basally, suturally, and apically, the intervals shining; the apices ending in a small curved caliper; the surface furrowed towards the apex and rugose. Abdominal segments densely punctate, the first armed with a long spine directed backwards. Length, $5\frac{3}{4}$ mm.

Two specimens of this platypid were cut out of the wood beneath the bark of a girdled blue pine at Konain in Jaunsar on 16 April 1902 by Babu B. Sen Gupta.

Crossotarsus fairmairei, Chap., var. wilmoti, Stebbing.

REFERENCE.—Stebbing (*Diapus*), *Depart. Notes*, i, 415.

Habitat.—North-West Himalaya.

Tree Attacked. Ban Oak (*Quercus incana*). Jaunsar.

Beetle.—The beetle resembles *fairmairei*. The colour is darker red, the thorax being entirely of this colour, as are the legs, with the exception of the tarsi, which are lighter brown.

Description.

The front of the head is only very finely pitted in the male, but strongly punctured in the female. The thorax is strongly constricted at the sides behind the middle and has no median line. The apical margin of elytra is concave in male, and in female truncate, with the outer edges produced into teeth curving inwards. The abdomen is concave behind in the female. Length, 5 mm. to 5.4 mm. Figs. 6, 6*a*, pl. xlv, show this beetle side and dorsal view.

Life History.

The insect is to be found on the wing at the commencement of June at elevations of 6,000 ft. It tunnels into the ban oak for egg-laying purposes. The beetle appears to prefer trees which are dead but not yet absolutely dry, and it bores down through the thickest bark into the heart-wood, making circular tunnels, the sawdust eaten out being ejected at the surface of the entrance-hole. A tree attacked can be easily detected by the presence of these small heaps of sawdust piled up on the outside bark. The tunnels may be quite straight or curved slightly. Both male and female beetles are to be found in the tunnel, and pairing probably takes place inside. The female insect appears to live for some time after egg-laying is completed, finally dying in the mouth of the tunnel and so blocking it to predaceous enemies. The eggs are laid at the bottom of the tunnel, and the larvae feed on fungous growths with which the walls of the tunnel are discoloured. The tunnels are as much as 9 in. to 12 in. in length. This is all that is at present known about the life history of this insect.

Damage Committed in the Forest.

As will be seen, the damage done is entirely to the timber of the tree, since the small portion of bast platypid beetles eat through on their way to the heart-wood is a negligible quantity. When plentiful the beetles entirely ruin the wood of a tree for timber purposes, and greatly reduce the value of fuel stacks.

Protection and Remedies.

When wood is badly attacked by these wood-boring beetles, the only safe method of destroying them and endeavouring to lessen their numbers in an area is to burn the whole of the infested timber and fuel. The actual hole or tunnel in the wood is, as we have seen, of small diameter, and therefore in itself of no great consequence. The damage done, however, when the beetles are numerous is economically very similar to that of the *Xylebori*. It has already been noted that *Xyleborus perforans* (p. 585) occasionally causes great loss of beer from beer-casks in India, and since the Hill Breweries in

North-West India make use of oak timber to a great extent it becomes of the first importance to have a working acquaintance with the wood-borers of the tree.

Platypus.

Platypus biformis, Chap.

(The Chir Pine Platypid Borer.)

References.—Stebbing, *Jour. Bombay Nat. Hist. Society*, vol. xviii, p. 19 (1907); id. *wilmoti*, *Ind. For. Mem.* Zool. ii, 36 (1911).

Habitat.—North-West Himalaya. Also reported from Darjeeling (*Coll.* Janson).

Tree Attacked.—Chir Pine (*Pinus longifolia*). Jaunsar, Kumaun, Chamba.

Description.

Beetle.—Elongate, cylindrical, rufous brown, shining; elytra slightly yellow-brown on sutural area. Head broadly transversal, prominent, as wide as prothorax; a median elevate longitudinal line on vertex, latter finely punctate; front concave, punctate-reticulate, with a median small circular depression or pit. Prothorax square, the median furrow terminated in front in an indistinct pit, followed by a median line; near the anterior portion of furrow a small, finely rugose patch, the rest irregularly rugose. Elytra striate-punctate, the first stria in the form of a furrow, the intervals nearly smooth, the third widened basally, 2 and 5 with a basal tubercle, all strongly and sparsely punctate, becoming tuberculate on the declivity, with a seta on each tubercle. In the ♀ a small projection just above apex on each elytron. Under-surface shining, punctate. Length, 5 mm. to 8 mm. The male and female beetles are shown in pl. lxiii.

Larva.—White and elongate, straight, with a well-developed head and prothoracic segments; abdominal segments tapering posteriorly. Length, $\frac{1}{4}$ in.

Life History.

This *Platypus* infests newly felled trees and also standing green ones. The insect in attacking a tree tunnels straight through the bark into the sapwood, carrying its tunnel for an inch or so into this before going off at an angle; from this latter point the gallery may have several sharp zigzags in it, as shown in fig. 1*b*. When completed, or nearly complete, a male and female beetle will be found in the tunnel, which is kept entirely free of wood-dust, this latter being pushed up and ejected on the outer surface of the wood or bark. As many as twenty or thirty eggs are laid by the beetle, and from them hatch out minute white dots, the size of pins' heads, which ultimately grow into small elongate larvae with yellowish heads. These larvae do not appear to feed on the wood, but on a kind of fungus with which the tunnel bored by the beetles is lined. The life-cycle of this beetle is about six weeks from egg to beetle, in the case of the autumn generation. Eggs laid about the first to second week of October hatch out within a couple of days or so, and the larvae are full-grown by the end of the month or first week in November. The pupal stage is about two weeks, and the mature beetles issue about the third week of the month should the weather prove favourable. I have not been able to work out the complete number of life-cycles passed through in

the year, but I am of opinion it will be found to be four or five. The first eggs of the year are laid about the middle of April, mature beetles from these issuing at the beginning of June; this is the first generation of the year. I found beetles of this generation issuing from a large dying tree in the forest near Chaubattia in Kumaun on 4 June 1908. The beetles of the second generation appear somewhere about the middle of July, those of the third at the end of August, whilst a fourth lot appear to oviposit in the second week of October. Should the year be a favourable one—I mean by this, should the autumn be a dry and warm one and the winter set in late—a fifth lot of beetles may develop towards the end of November, and hibernate as such. Should the year be unfavourable, the insect probably hibernates in the larval stage at the bottom of the tunnels in the wood.

Such is the life history of this pest as far as it has at present been worked out in the Western Himalaya. Colonel Sampson considers the species to be identical with Chapuis' *biformis* taken in the Darjeeling district and named from specimens in the Janson Collection. It will he of interest to know what the food plant of the insect is in the Eastern Himalaya. As I have said, in the western part of the range it only attacks the wood when fresh. In no instance have I found the insect alive in dry timber.

Relations to the Forest.

I first took this insect in the Tons Valley, Jaunsar, in October 1906. In a paper in the *Journal of the Bombay Natural History Society* for 12 November 1907, I replied to Mr. Norman F. Troup, of Kumaun, who had asked in a previous number for some information on the subject of the shot-borers of the *Pinus longifolia*, which he imagined were identical with those of the bamboos (*Dinoderus*). From investigations of these "shot-borers" of the *Pinus longifolia* made the following spring in Kumaun, I was able to satisfy myself that the *Platypus* was the responsible agent.

The damage committed by this insect is to the timber of the tree. From the account given of its life history we see that but little harm is done to the cambium layer. When the beetle is numerous the zigzag galleries eaten down into the heart-wood have a serious effect in weakening the log for timber purposes, and can quite conceivably render it useless for anything but firewood.

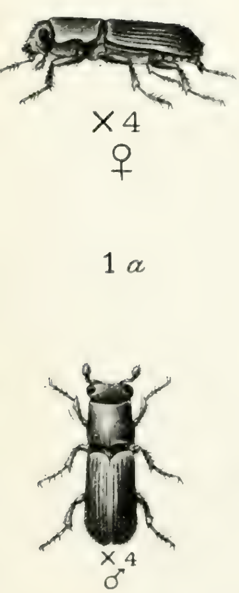
As Mr. N. Troup has shown, the beetle is well known to timber dealers in Kumaun, where it is considered to be a pest of considerable importance.

Protection and Remedial Measures.

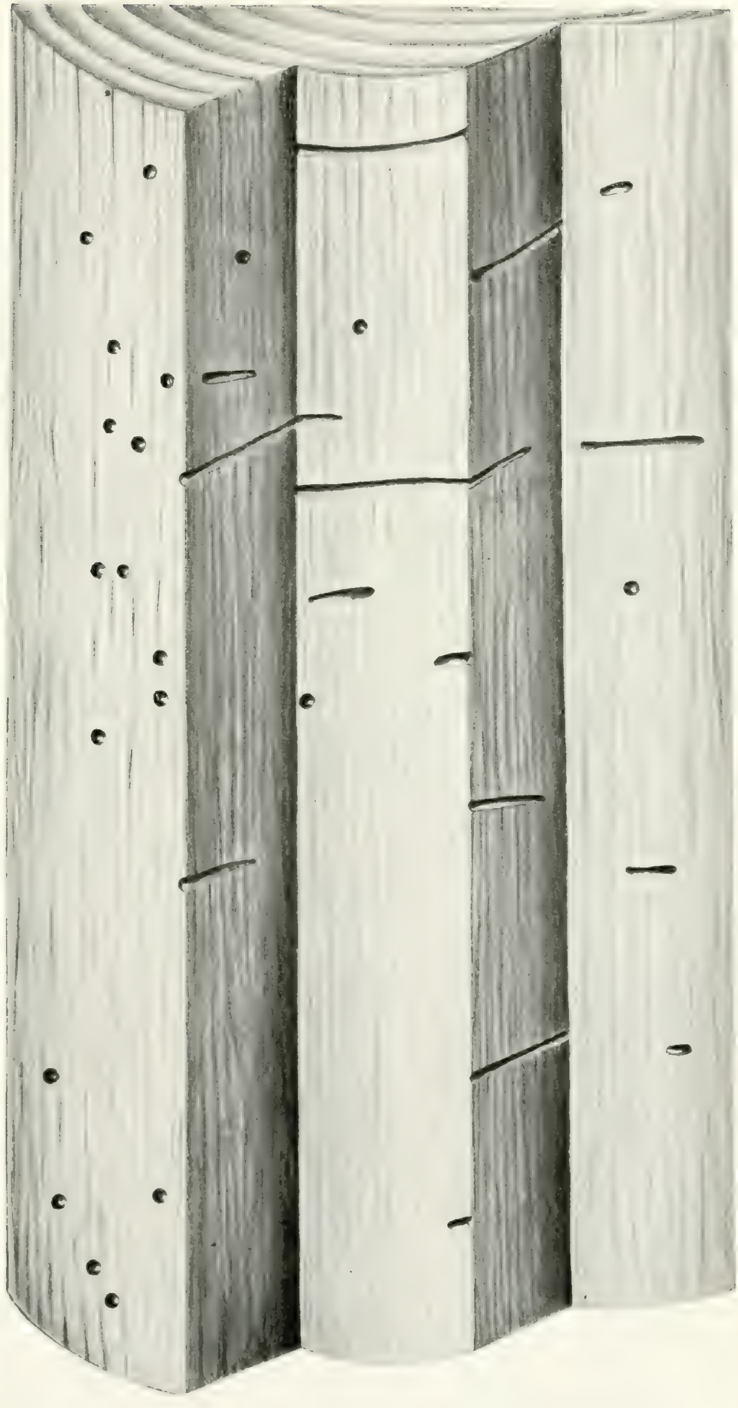
There is little to be said upon this head at present, until it has been definitely ascertained whether the insect will tunnel into barked timber. It is now certain that the insect will only infest fresh timber, i.e. newly felled trees or sickly standing green trees in the forest.

Practically the only way to deal with a bad attack or seriously infested depots would be to stack together all the badly attacked logs when the beetles have finished egg-laying, and burn the lot.

1



1 *a*



1 *b*

Platypus biformis, Chap., in *Pinus longifolia*. — 1, 1*a*, male and female beetles ; 1*b*, section of the trunk of a tree showing entrance-holes and egg-tunnels of the beetles in the wood. North-West Himalaya.

Platypus suffodiens, Sampson, sp. nov.

REFERENCE.—Sampson, *Ann. Mag. Nat. Hist.* ser. 8, xii, 447 (1913).

Habitat.—Lower Burma.

Trees Attacked.—*Adina sessilifolia* and *Adina cordifolia*; the Rain Tree (*Pithecolobium saman*). Tharrawaddy.

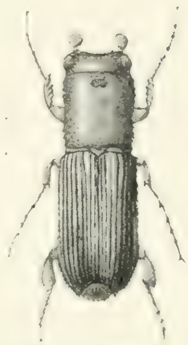


FIG. 392.—*Platypus suffodiens*, Samps., sp. nov. Lower Burma.

Description.

Beetle.—Moderately shining chestnut brown, the head and elytra in apical half dark brown to black; under-surface lighter chestnut, the thoracic segments and legs yellow. Head finely punctate, front concave. Prothorax shining, subquadrate, with scattered punctures; a small blunt-elliptical area with a rasp-like surface situated medianly a short distance below anterior margin; disk with a longitudinal elongate elliptical depression laterally. Elytra striate-punctate, the sutural striae most prominent, interstices shining, minutely punctured. Two small projections on apical depression, one on each elytron, shortly above apex; apical depression convex, surface dull and roughened, clothed with a stiff sparse yellow pubescence. Under-surface very shining and finely punctate. Length, 4.8 mm. to 5.2 mm.

Larva.—Elongate, slightly tapering posteriorly, white with a small yellow head and brown mandibles. The prothoracic segment ridged behind the head.

Life History.

I took a number of these beetles maturing in green *Adina sessilifolia* and *A. cordifolia* trees or tunnelling into them to oviposit at the beginning of February 1905 in the Tharrawaddy forests. A study of the method of attack was thus possible under favourable circumstances. A beetle, possibly the male, tunnels down through the bark and into the sapwood for a short distance, and then eats out a short gallery at an angle to the previous direction. In this a female joins him, is fertilized, and then carries a tunnel which goes down into the wood, usually curving to right or left to a certain extent. At the bottom of this tunnel, which at times is carried clean through the stem, terminating in the outer sapwood on the opposite side, she lays her eggs. The larvae on hatching out feed upon the sap in the walls of the tunnel or upon outgrowths which develop in this sap. They evidently move about in the tunnel, the oldest being the highest up, the youngest at the bottom of the row. The immature beetles also move up and down the tunnel to some extent before finally emerging. The greatest number of grubs taken in one tunnel was five, but at the period when they were taken (beginning of February) mature beetles were also present in other tunnels in the tree, as also pupae. It is a matter of considerable importance to ascertain the number of eggs laid by these platypids, since it is by no means easy to follow the curving and sometimes winding tunnels in the hard wood, more especially because the wood is usually fresh and sappy and does not lend itself to splitting well in most instances. When the tunnels are numerous they run so close to one another down in the wood that it becomes a matter of considerable difficulty to follow with certainty the one being studied. The

plate (pl. lxiii) depicting the *Platypus* of the *Pinus longifolia* shows the manner in which the tunnels are carried. Also cf. fig. 390.

I first took some specimens of this beetle in their egg-tunnels (which were not complete) several inches down in the wood of an *Adina sessilifolia* tree on 22 January 1905 in the Kadin Bilin forests in Tharrawaddy. I have no information as to how many generations the species passes through in the year.

I also took a specimen of this platypid tunnelling into the green branches of a large rain-tree in the compound of one of the forest bungalows in the Tharrawaddy Division. The *modus operandi* of the insect is very similar to that in the *Adina cordifolia* already described. The beetle was found down in the centre of the branch at the end of January 1905.

Damage Committed to Timber.

The *Adina cordifolia*, the haldu of Northern India, is a wood of some value, and therefore the attacks of an insect of this description require to be well known. I have noticed the attacks of a platypid, I think of a different species from the Burma one, in the United Provinces forests, but so far it has not become evident as a pest. The danger of the insect is that it infests and requires absolutely fresh green timber for its ovipositing operations. Whilst in Tharrawaddy, in company with Mr. R. S. Troup, at the time the Divisional Officer, we had an excellent demonstration of this fact. We carefully inspected a green living and apparently healthy standing tree in the lower part of which a number of these platypids were tunnelling into the timber. We could find nothing wrong with the tree, and yet a swarm of the beetles had descended upon it, and many were already deep down in the heart-wood, having tunnelled with impunity through the thick succulent bark and the sappy sapwood. The freshly made tunnels were oozing with sap, but this did not appear to incommode the insects. This particular instance remains the most remarkable example of attack I have seen by platypid beetles. About ten yards away a second green tree stood. It had been cut half through but was still quite green, and the tree would have in all probability lived in such a damp hot climate. The lower parts of the trunk were, however, full of the tunnelling beetles.

The wood of *A. cordifolia* is an excellent one for turning, and is used for a variety of purposes, such as articles of furniture, combs (in which there is a considerable trade in the United Provinces), small boxes, agricultural implements, etc. It will be readily acknowledged that logs infested by this insect to any considerable extent would be quite unfit for any of the above purposes.

Treatment.

The attack of this insect when in any abundance is, fortunately, fairly easily seen once the forester knows what to look for. The entrance-holes in the bark are usually discernible, and beneath them on projections of bark may be seen little masses of white or yellow sawdust, whilst at the foot of the tree in cases of bad attacks, such as that observed by Mr. Troup and myself, masses

of sawdust will be observable. A tree badly infested in this manner should be watched for a couple of weeks, and as soon as it is apparent that no more fresh sawdust is being ejected from the orifices in the bark it should be felled and the whole of the infested portions be split up and burnt. It will not be necessary to deal with the uninfested portions, i.e. the parts which show no entrance-holes on the outside, as they will not contain any of the maturing larvae or pupae. A generation of the insect probably takes about two months to mature from egg to beetle. It is of importance that the generation in the tree should not be allowed to approach the mature-beetle stage before being dealt with, or some of the insects will escape from the tree to carry on the attack.

Hectarthrum heros, Fabr. (pp. 116 and 166).—This insect was taken in considerable numbers beneath the bark and sapwood of trees infested with the platypid dealt with above, upon which it is undoubtedly predaceous.

Predaceous Insect.

Beetle.—Shining black. Antennae long and prominent, eleven-jointed, the middle joints much larger and broader than the rest. Thorax smooth, shining. Elytra with a number of prominent raised parallel longitudinal striae down them. Length, 12 mm.

This is one of the commonest of the *Hectarthrum* beetles in India. It varies considerably in size. It is a most useful insect in the forest, and should be recognized as such. Its grubs enter the tunnels of the platypids and feed upon the platypid larvae.

Platypus rectangulatus, Sampson, sp. nov.

REFERENCE.—Sampson, *Ann. Mag. Nat. Hist.* ser. 8, xii, 448 (1913).

Habitat.—Lower Burma.

Tree Attacked.—*Anogeissus latifolia.* Tharrawaddy, Lower Burma.

Beetle.—Small, elongate, cylindrical, narrow. Shining. Dark ferruginous brown, head and apex of elytra nearly black, middle three-fifths of elytra yellow or yellowish green, ♀ paler than ♂. Head prominent, wider than prothorax, front finely punctate. Prothorax two-fifths length of elytra, sides sinuate, irregularly punctate. In ♂ about fifteen punctures on each side of the anterior extremity of the median sulcus. In ♀ a broad patch of punctures extending the whole length of the median sulcus. Elytra with apex truncate or ending in callipers, finely linear-punctate, basal fifth dark brown, apical fifth nearly black, rest yellow. Under-surface and legs shining yellowish brown. Abdominal segments dark brown. Length, 3 mm. to 3.2 mm.

Description.

FIG. 393.—*Platypus rectangulatus*, Samps., sp. nov. Tharrawaddy, Lower Burma.

Larva and Pupa.—The larva is white, straight, elongate, and thin. Pupa white with prominent black eyes.

This platypid was found in all stages of its metamorphosis, with the exception of the egg stage, in tunnels in the wood of *Anogeissus latifolia* towards the end of January 1905 in Tharrawaddy. It was taken from a large tree felled in a 1904 tounggya clearing. Some of the beetles were mature and ready to

Life History.

issue, but in no case did I find any of the beetles tunnelling into this tree for ovipositing purposes, the wood now being too dry. The beetle evidently only tunnels into the fresh sappy wood of newly felled trees or into standing sickly ones. The female beetle bores her egg-tunnel right into the heart-wood and lays her eggs in a manner similar to the platypus of the *Adina*. The insect had infested the tree in considerable numbers in the thicker part of the trunk.

It is probable that there are at least two generations of the insect in the year.

Hectarthrum heros, Fabr. (p. 116).—This cucujid was found in the tree infested by this platypid in some numbers, and was engaged in preying upon the *Platypus* beetle. **Tachyta nietneri** (p. 96) was also present.

Trachypholis hispida, Weber (p. 113).—This beetle was taken in company with the platypus.

Platypus solidus, Walk.

REFERENCES.—Walker, *Ann. Mag. Nat. Hist.* vol. ii, 3rd ser. p. 286; Chapuis, *Mongr. Platy.* 267 (1866).

Habitat.—Lower Burma. Also reported from Ceylon, Malacca, etc.

Tree Attacked.—*Anogeissus latifolia.* Tharrawaddy.

Beetle.—Elongate, the elytra sharply constricting to apex in upper third. Moderately shining. Dark ferruginous brown, apical half almost black, antennae and legs paler. Head slightly concave on front, latter rugose, punctate anteriorly, reticulate behind. Prothorax with a median furrow, punctate, the punctures stronger behind and on each side of the median furrow. Elytra striate-punctate, the striae and punctures very fine on basal part, becoming stronger and denser in apical portion, the inner striae most pronounced, the punctures close; declivity smooth and shining, with deep striae; the apex of each elytron produced into a blunt point; abdominal segments finely punctate and granulose. Posterior femora with a very sharp tooth. Length, 3.8 mm. to 4 mm.

Description.

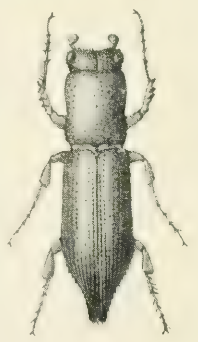


FIG. 394. *Platypus solidus*, Walk. Lower Burma.

A specimen of this insect was taken from a tunnel bored vertically down through the bark into the heart-wood of a large felled *Anogeissus* tree in a 1904 tounggya teak plantation in Tharrawaddy. The insect was evidently engaged in ovipositing. It was taken on 22 January 1905.

The insect is very variable, and Chapuis distinguishes three varieties from Malacca and elsewhere in the Indian Archipelago.

Platypus curtus, Chap.

REFERENCES.—Chapuis, *Mongr. Platy.* p. 261 (1866); Stebbing (*Platypus* sp.), Assam Sál Ins. *For. Bull.* no. 11, p. 46 (1907).

Habitat.—Assam. Also reported from Singapore and Sarawak (*Coll.* Wallace).

Tree Attacked.—Sál (*Shorea robusta*). Goalpara.

Beetle.—Stout, robust, short, abruptly truncate posteriorly. Dark brown, apical half of elytra black and set with golden yellow stiff short hairs. Head with front flat, dull, punctate-rugose, finely reticulate between the eyes ; club of antennae not articulate. Prothorax square, with a longitudinal median carina, a small oval rugose patch on each side in front of carina, and scattered largish punctures. Elytra short, widened behind, with a strongly punctured sutural furrow, the striae weak and multi-punctate, the intervals sub-convex, with a double row of fine points bearing inclined hairs. Declivity oblique, sub-circular, with dull furrows, the intervals with double rows of spiny granules. Abdominal segments densely punctate-rugose. Posterior trochanters punctate, each terminated with a double spine. Length, 3.7 mm. Pl. lx, fig. 8, shows this insect. The curious short squat thorax and elytra give a characteristic appearance to this species.

Description.

Life History.

This is a common beetle in freshly felled sál-trees in the latter half of May. It was taken in numbers from a green tree felled in the Kachugaon forests on 15 May 1906 and also from other felled green trees. In all cases it had attacked the trees after they had been felled. It was, however, also cut out of green sickly dying standing trees. The insect evidently only attacks green wood, and is not to be found in dead wood.

The beetle was ovipositing in the latter half of May, the beetles then taken being probably those of the first generation of the year laying the eggs of a second. The egg-gallery may go in through the bark at a slight angle, but on reaching the sapwood the beetle tunnels straight down into the heart-wood. There are no offset galleries to the main one, the eggs being laid at the bottom of this latter. The larvae on hatching out of the eggs appear to feed upon fungi lining the walls of the egg-gallery, since in old tunnels examined there was no evidence of any larval gallery or tunnel eaten in the wood.

The beetle will attack the wood with the bark on or off, so that barking the felled tree is no protection against it. It enters a log with as much facility at a cut end as by boring down through the bark. This habit is of considerable interest and importance, since other species I have examined, as detailed above, would appear to require the bark on the stem as a condition of attack. The presence of this platypid is easily recognizable, as the particles of wood eaten out in making the gallery are pushed up the tunnel and ejected from the mouth of it either in the form of little heaps of wood-dust or, more usually, as little cylindrical wood masses which project upwards out of the bark. The colour of these cylinders will at once tell the observer how deep the beetle has got into the wood.

When numerous this platypid badly pin-holes freshly felled sál-trees, standing sickly trees, and freshly sawn logs lying in the forest. For this reason felled trees should be converted and removed from the forest as soon as possible.

Tillicera assamensis, Steb. (p. 187), is predaceous upon this platypid. It is described on p. 486.

Platypus cupulatus, Chap.

REFERENCE.—Chapuis, *Mongr. Platy.* p. 278 (1866).

Habitat.—Tenasserim, Lower Burma. Also reported from Borneo, Sarawak (*Coll.* Wallace).

Tree Attacked.—*Terminalia belerica.* Natchoung, Ataran River.

Description.

Beetle.—♂ Front of head flat, sparsely and strongly punctate with a very short smooth stria medianly. Prothorax oblong, the median furrow faint, a smooth median line in front, a small patch of close punctures on each side, rest with scattered rather large punctures. Elytra striate-punctate, a deep sutural stria, with faintly marked striae near base, the intervals with scattered punctures; apical depression obliquely subquadrangulate, the sutural margin longest, surface densely punctate, with a shallow pit near sutural angle. Abdominal segments rugose-granulose, the last most strongly so and scarcely concave.

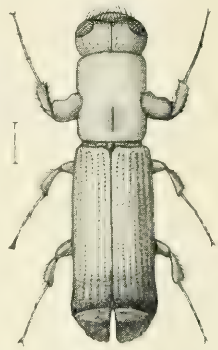


FIG. 395.—*Platypus cupulatus*, Chap. Tenasserim, Lower Burma.

♀ Front less strongly punctate. Prothorax with the median furrow and line longer than in ♂. Elytra more deeply punctate-striate, the intervals more regularly and finely punctate. Apical depression circular, very concave, shining and nearly smooth; sutural angle prolonged backwards. Abdomen nearly flat, the segments finely punctate. Length, ♂ ♀ 5 mm.

Life History.

The female tunnels down into the heart-wood of the tree, the tunnel going straight in for a couple of inches or more and then curving to the right or left. The insect is of fair size, the tunnels thus having a considerable diameter, whilst the entrance-holes are easily visible on the outer bark. The eggs, as is usual, are deposited at the bottom of the tunnel. I took a number of dead beetles, mature and partially mature, in the tunnels on the 10th of March 1905. They had apparently been killed *in situ* by a fire which had been lit to clear the compound of rubbish, the dead *Terminalia* in which they were found lying in the compound of the forest bungalow. The tunnels showed signs of age, indicating that they had been made whilst the wood was still green and sappy.

Platypus talurae, Stebbing.

REFERENCE.—Stebbing (*Diapus*), *Depart. Notes*, i, 418 (1906).

Habitat.—Coimbatore, Madras.

Tree Attacked.—*Shorea talura.* North Coimbatore.

Description.

Beetle.—Elongate, narrow, shining. Head and thorax dark chestnut-brown, almost black; basal margin, sides, and apical portion of elytra chestnut-brown, rest pale yellow. Antennae yellowish brown, legs pale yellow. Head vertical, broader than thorax, shining and glabrous; eye vertical, pale silvery yellow. Antennae set with long curved yellow hairs on scape and funiculus; scape subcylindrical, longer than funiculus. Thorax oblong with shallow depressions on anterior half, emarginate at sides before middle, basal margin bisinuous, finely pitted with a median line. Scutellum is large, triangular, and separates the elytra at the base.

Elytra smooth, finely punctate-striate, their apices produced into points in the female, concave in male. Last abdominal segment pubescent. The thighs of the middle pair of legs fit into sockets on the mesosternum. Length, ⅛ in.

Egg.—Very small, in shape like a hen's egg, translucent and colourless, shining. Length, .4 mm.

Larva.—Not full-grown. White, legless, elongate, and not curved. Length, $\frac{1}{10}$ in. in largest specimens obtained. Fairly active.

FIG. 396.—*Platypus talurae*, Steb. Coimbatore, Madras.

Life History. This beetle is to be found on the wing at the beginning of August in Southern India, and lays its eggs in wood at this period. On 6 August 1902 beetles' eggs and newly hatched larvae were discovered in the wood of *Shorea talura*. The beetles bore circular tunnels right down into the heart-wood of the *Shorea*. From the lower part of these tunnels small offshoot galleries at right angles to the main one are cut out, and the eggs laid in these. The main tunnel appears invariably to be bored right down into the heart-wood, and in the case of a felled tree is bored vertically downwards through bark and sapwood. The larvae are "ambrosia" feeders, feeding upon a kind of fungus growing on the walls of the parent beetle's tunnel.

This beetle bores into comparatively fresh *Shorea talura* wood. The tree which it was found attacking had been felled in the preceding April for road-repair work. Until more is known about its life history its importance in the forest cannot be determined.

Platypus sp. nov.

Habitat.—Upper Burma.

Tree Attacked.—*Wendlandia tinctoria*. Kadu Hill, Katha.

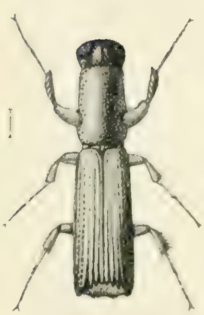


FIG. 397. *Platypus* sp. Kadu Hill, Katha.

Beetle.—Elongate, narrow, shining. Head and apices of elytra black, thorax dark brown, elytra and legs yellowish brown. **Description.** Head punctate. Thorax smooth and shining; finely and uniformly punctate; elytra widest at apical extremities, striate and punctate. Length, 3.8 mm. As this insect is represented by a single individual only, Colonel Winn Sampson is unwilling to describe it until more are procured.

Life History. This insect was cut out of its tunnel deep in the wood of a newly felled *Wendlandia* on the Kadu Hill in Katha on 21 February 1905. It was engaged in eating out its egg-tunnel. I took only the one specimen of the insect. The wood was fresh and sappy.

Platypus sp.

Habitat.—Upper Burma.

Tree Attacked.—*Wendlandia tinctoria*. Kadu Hill, Katha.

Description.

Beetle.—Large, reddish brown, shining. Prothorax finely punctate, smooth. Elytra strongly striate-punctate, the striae prominent and strongest basally, interspaces broad and punctate. The specimen has the head, anterior portion of prothorax, and the posterior end of abdomen missing. Length of mutilated specimen about 9 mm.

This *Platypus* is therefore of considerable size.

Life History.

I found a specimen of this insect embedded in the wood of a large newly felled *Wendlandia tinctoria* in the clearing on the summit of Kadu Hill in Katha on 21 February 1905. The beetle was dead and mutilated, and wedged into its tunnel, which penetrated deep down into the tree.

DIAPUS.

Diapus impressus, Janson.

REFERENCE.—Janson, *Ind. Mus. Notes*, iii, 1, p. 74 (1893).

Habitat.—North-West Himalaya.

Tree Attacked.—Ban Oak (*Quercus incana*). Jaunsar.

Description.

Beetle.—Elongate cylindrical, with a vertical exserted head, broader than thorax, and weak legs. Red-brown, shining, basal margin of the thorax and elytra brownish yellow, apical posterior of the latter red-brown; legs and antennae pale yellow. Thorax oblong, strongly emarginate at sides before the middle, base finely and closely punctured and with a slight median line. Elytra punctate-striate, the second striae from suture and the outer marginal one broader and more strongly punctured, the first and second interstices from the suture strongly raised, the fourth slightly convex; the apex coarsely punctured, subtruncate, and unarmed in the male, in the female with five acute apical spines. Under-surface light orange-yellow between the second and third pairs of legs, brown anteriorly to this, and dark brown to black on abdominal segments, which are very short. Abdomen densely pubescent at apex in male, in the female concave, rugulose. Length, $3\frac{1}{2}$ mm. to 4 mm. (Pl. xlv, figs. 5, 5 *a*.)

Larva.—White, legless, straight, with a light orange-yellow head and black mandibles.

Life History.

The only specimens of this insect taken appear to have been sent to the Indian Museum, Calcutta, from Deoban, Jaunsar, in December 1891. The insects were reported as tunnelling into ban-oak stumps, but nothing further appears to be known about them.

Diapus (?) heritierae, Stebbing.

REFERENCE.—Stebbing, *Depart. Notes*, i, 420 (1906).

Habitat.—Bengal.

Tree Attacked.—Sundri (*Heritiera littoralis*). Backerganj, Sundarbans (Sen Gupta).

Beetle.—Elongate, narrow, shining. Head dark chestnut-brown or black; thorax chestnut-brown; elytra pale yellow, slightly tinged with chestnut on basal margin and merging into pale chestnut-brown in upper third, becoming chestnut-brown in apical fourth. Antennae yellow, legs chestnut-brown. Head vertical, not broader than thorax, rugose, with scattered spiny yellow hairs on front. Thorax about a quarter as long again as wide, only slightly emarginate at sides below middle, anterior margin straight; glabrous, and finely punctate. Elytra striate-punctate: four striae prominent at base, the outer marginal one most prominent, the second from suture becoming less marked soon after leaving base, the first interstice from suture raised, the fourth strongly raised and convex, with scattered large punctures; a depression between second and third striae depressed at base; apex truncate, showing eight well-defined ridges, the depressed portion in ♀ set with five teeth on side and four apical ones, of which the outermost is prolonged and turned outwards; ♂ unarmed; the truncate portion and marginal edges of elytra set with yellow spiny hairs, denser apically. Under-surface brown, abdominal segments dark-brown to black, and very short; concave and rugulose in ♀. Anterior tibiae toothed on outer edge. Length, ♂ 4.7 mm., ♀ 3.9 mm.

Description.

This insect was first found by Ranger B. C. Sen Gupta tunnelling into sundri (*Heritiera littoralis*) wood in June 1902. An examination of some pieces of attacked timber showed that the insect bored right down into the heart-wood, the gallery made by the beetle being quite straight. The following year the Ranger was able to make some further observations on its habits in the beginning of April. The following is a summary of his valuable investigations. He found two beetles of different sizes in the pieces of wood (probably ♂ and ♀). His study of the habits led him to conclude that the adults bore through the wood into the sapwood and lay their eggs. They probably do not go into the heart-wood at this stage, as he found that in all the newly attacked wood the heart-wood was left untouched: it was only after some period that the galleries were found in the heart-wood. Only a few eggs are laid in each tunnel; the number, however, has not been observed. The larvae did not appear to bore galleries in the wood, but were to be found at the bottom of the parent's tunnel. This latter may branch (or curve?) when it has been carried right down into the wood. The larvae pupate at the ends of the galleries, and the adults on maturing make fresh borings into the timber as long as it is sufficiently fresh for their purpose. The galleries are very small (about one-thirteenth of an inch in diameter), and the adult beetles continually move up and down the tunnels. This insect is another of the so-called "ambrosia" beetles, and the reason for the non-discovery of larval tunnels is due to the fact that the larvae probably live upon a fungous growth which develops on the walls of the tunnel of the parent beetle. Since the mature insect is found in April and again in June there are evidently two generations in the year, and probably several. These beetles attack sundri wood as soon as it has been felled, and as long as it is fresh. They will not touch dry wood. Their old galleries can be seen in this latter, but no living beetles are ever found in them. They only attack the sundri in this locality. Other kinds of wood, green and half dry, are left untouched.

Life History.

Relations to the Forest.

This insect was found by Ranger B. C. Sen Gupta at Wazirpur, in the Backerganj District in Bengal. The wood in which the beetles were found was, however, brought in boats from the Sundarbans, the latter place probably being the true habitat of the insect.

This *Diapus* bores into the wood of both green and half-dry sundri. It infests stacks of this wood in the Sundarbans, sometimes in large numbers, and at times, according to Ranger Gupta, completely riddles and spoils the timber. The presence of the bark on the wood is immaterial, since the insect will burrow down into unbarked timber with equal ease.

Although the beetles were found in the Backerganj District it was always in timber that had been brought from the Sundarbans forests, and the beetle is probably indigenous to those forests (from which all the sundri comes) and is carried about in the wood when it is exported. The timber is always carried in boats, the latter proceeding through the various mouths of the Hooghly River and their connecting network of canals to Calcutta and the surrounding Eastern Bengal towns and villages.

Diapus furtivus, Sampson, sp. nov.

REFERENCES.—Sampson, *Ann. Mag. Nat. Hist.* ser. 8, xii, 450 (1913); Stebbing (*Diapus* sp.), Ass. Sál Ins. Pests, *For. Bull.* no. 11, p. 43 (1907).

Habitat.—Assam; Central Provinces.

Tree Attacked.—Sál (*Shorea robusta*). Goalpara; Banjar Valley, Mandla, Central Provinces.

Description.

Beetle.—Minute; ferruginous brown or black, shining; elytra sometimes with yellowish patches on the median portion. Head punctate, with front concave, the antennae inserted in a line almost parallel with upper edge of eyes; at base of each antenna, on inner side, arises an oval excrescence, larger than eyes themselves, and covered with deep punctures; a small bunch of bright yellow hair is placed at the centre of the epistoma, and smaller ones at the apical frontal angles near the insertion of the mandibles. Thorax oblong, a very short basal median line with eleven large pores irregularly placed on either side; with very fine transverse striae on posterior parts, the median area being smooth. Elytra with very strongly raised longitudinal ridges, which starting from the base become stronger as they approach the apex, and are prolonged into short blunt spines which project from the elytra at the point where the latter are declined downwards at apical end. A prominent spine projects from the median apical end of the elytra. This elytral armature is only present in the ♀, the apical ends of elytra in ♂ being truncate and straight; feebly lineate-punctate, the interstices flat with minute punctures. Last segment of abdomen in ♀ deeply concave and coarsely punctured Length, ♂ 3.5 mm. to 4 mm., ♀ 4 mm.

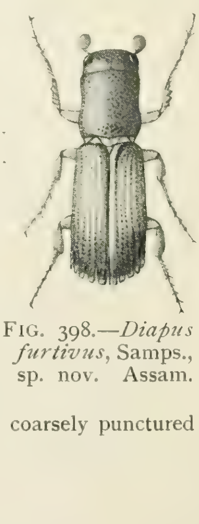


FIG. 398.—*Diapus furtivus*, Samps., sp. nov. Assam.

Life History.

This tiny platypid was very plentiful in the Kachugaon forests in the latter half of May 1906. Within twenty-four hours of a tree being felled it made its appearance and at once commenced to tunnel down into the wood, entering through the bark or at one end of the logs. It drills circular tunnels more or less straight, except at their commencement, into the sapwood. The insect infests both the main stem and the larger branches. This little beetle differs from most platypids owing to its great activity. Most of these insects have very long, slender, weak tarsi, and are quite unable to progress at all fast when out of their tunnels. This one, however, is able to run about over the sál bark at a very rapid rate. It appears to infest only green wood, and attacks standing green sickly trees as well as newly felled ones.

I took a generation of this insect maturing in the Central Provinces sál forests in the middle of April 1909, from eggs laid by beetles which appeared some time late in February or early in March. From large green sál-trees felled in the Banjar Valley I cut out maturing beetles, the eggs from which their grubs had hatched having evidently been laid in the trees after they had been felled in the previous February. I found other beetles tunnelling into newly felled trees in the middle of April to oviposit. The platypid tunnels down through the thick bark, selecting fresh sappy trees and tunnelling in near the base of the tree in the butt or into the stump, and then goes straight down into the sapwood, the tunnel curving here and entering the heart-wood. The eggs are evidently laid at the bottom of the tunnel, the grubs feeding on the sap or on outgrowths on the walls of the tunnel.

As in Assam, the timber, when the insect is numerous, is badly pinholed on the external surface.

Damage Committed in Forest.

The damage committed by this insect is very similar to that described for other species of platypid. The timber, so far as the sapwood is concerned, is badly pinholed, giving the logs the appearance of being more badly affected than they are in reality. This insect evidently appears in large numbers in areas where fellings are made in the forest.

Platysoma ? sp. (p. 106).—This histerid is, I think, predaceous upon this platypid and *D. mirus*, and perhaps upon the sál-wood *Platypus* of Assam (*P. curtus*).

Predaceous Insects.

Beetle.—Smaller than the one attacking *Sphaerotrypes assamensis* (p. 487). Black, shining, compact, with black smooth thorax and striate elytra, the striae far apart. Two posterior segments of the elytra are exposed. Pl. lx, fig. 11, shows this beetle.

Life History.—Not common. It was taken from beneath the bark of the sál-tree felled on 13 May 1906 in the Kachugaon forests in Goalpara. It was apparently engaged in entering the tunnels, probably for ovipositing

purposes, of the wood-borers. *Diapus furtivus* appeared likely to be the chief of its hosts.

Tilliœra assamensis, Steb. (p. 187), is predaceous upon this *Diapus* and upon *D. quinquespinatus* and *D. mirus*. It is described on p. 486.

Hemiptera.—This small bug is predaceous upon the *Diapus*.

Insect.—Black. Head small, pointed anteriorly with short four-jointed antennae. Thorax convex-punctate. Abdomen black; elytra membranous. Under-surface black; antennae and legs crimson brown. (Pl. lx, fig. 12.)

Life History.—This small bug was taken in company with the small wood-boring *Diapus* in the green sál-trees felled at Kachugaon in Goalpara. It appeared to be predaceous upon the platypids. It was also taken in slabs cut from trees felled in February 1906.

Diapus quinquespinatus, Chap.

REFERENCES.—Chapuis, *Mongr. Platy.* p. 335 (1866); Stebbing, Assam Sál Insects, *For. Bull.* no. 11 (1907).

Habitat.—Assam. Also reported from Borneo and New Guinea (*Coll.* Wallace et Janson).

Tree Attacked.—Sál (*Shorea robusta*). Kachugaon, Goalpara.

Description.

Beetle.—Brownish black, shining, elytra brown, posterior edge of prothorax, antennae, and legs ferruginous yellow. ♂ Front of head slightly convex, with a median line; the mandibles armed with an appendage. Prothorax oblong, with a narrow median furrow with a faintly marked pit anteriorly. Elytra striate-punctate, the second furrow prominent from base to apex, the intervals irregularly punctate, 3 most prominent at apex and extremity; elytra thickened behind with a narrow deep transverse marginal furrow; last abdominal segment smooth, edged with long hairs. ♀ Front of head sparsely and strongly punctate. Prothorax subquadrate, shorter and wider than in ♂, sparsely and finely punctate, the punctures stronger laterally, with a few large ones on each side of median line. Elytra with the second furrow prominent, the intervals finely and sparsely punctate: 3, 5, 7, 9 prolonged into a prominent sharp spine; 2, 4, 6, 8 constricted behind, lengthening successively from innermost outwards and terminating in short sharp spines; last segment of abdomen more or less densely granulose. Length, ♂ ♀ $2\frac{1}{2}$ mm. Pl. lx, fig. 9).

Life History.

This beetle was taken plentifully from the sál-trees felled during my stay in the Kachugaon forests (i.e. between 15 and 23 May 1906). The first specimens were taken on 15 May from the tree felled on the 13th of that month. Like *furtivus*, the beetle tunnels into the wood of the tree, entering either at the end of a log or through the bark. The hole made is of considerably smaller diameter than that of *Platypus curtus*, and in this way the attacks of the *Diapi* can be distinguished on the outside from those of their companion, the little cylinders of ejected wood having a considerably narrower diameter.

Diapus mirus,* Sampson, sp. nov.

REFERENCE.—Sampson, *Ann. Mag. Nat. Hist.* ser. 8, xii, 452 (1913).

Habitat.—Assam Sál Areas.

Tree Attacked.—Sál (*Shorea robusta*). Goalpara.

Beetle.—Small, shining. Head black, prothorax dark brown, elytra yellowish green, apical third brown. Under-surface of metathorax dark brown, rest lighter-coloured; legs yellowish brown. From anterior edge of front of head arises a transverse ridge of stout yellow hairs divided into four groups which extend upwards and backwards over whole front to middle of vertex; between the eyes are two large clusters of similar hairs, also divided into groups, the inner pair of which extend straight out from front, but are slightly bent downwards at tips and then end abruptly, having a total length of over .5 mm.; the other two groups are twisted round the first pair and then cross the middle of the front, thus concealing nearly the whole frontal surface. Prothorax smooth, with a group of pores as in *furtivus*, with two depressions placed transversely on anterior third of disk. Elytra very finely striate-punctate, the apex rounded. Length, 3.7 mm.

Description.

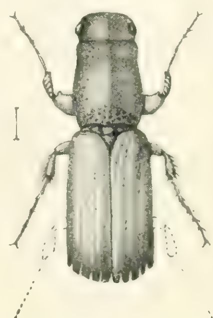


FIG. 399.—*Diapus mirus*, Sampson, sp. nov. Goalpara, Assam.

Life History.

This platypid was taken commonly in company with *D. furtivus* and *D. quinquespinatus*, tunnelling into newly felled sál-trees in the Kachugaon forests in May 1906. Its life history is probably not unlike that of its companions already described.

Diapus capillatus, Sampson, sp. nov.

REFERENCE.—Sampson, *Ann. Mag. Nat. Hist.* ser. 8, xii, 449 (1913).

Habitat.—Darjeeling, Eastern Himalaya.

Tree Attacked.—Búk (*Quercus lamellosa*). Darjeeling Forests (C. G. Rogers).

* In a communication dated 6 January 1914, Colonel Winn Sampson wrote me as follows with reference to this species:—"I have just had news from Dehra Dun that upsets my species *Diapus mirus*. It seems that during the marriage flight the ♀ *D. furtivus*, mihi, has a large cluster of frontal hairs (which I fully described, but as belonging to the ♂, not having material for dissection); when she commences boring these clusters are "cast off" I am informed (more probably worn off I should imagine!). From specimens just sent me, I have determined the sexes to be the reverse of what I thought, and my mistake is excusable as I could not know that the, generally ♂, characteristic of a hairy front was reversed in these insects or that these hairs were lost in later life. A still more extraordinary thing is, that the ♀ has the insertion of the antennae level with the upper edge of the eyes, whilst in the ♂ they are much lower down the front. . . . This (if correct) reverses my sexes of *D. furtivus*, and *D. mirus* becomes a synonym, being the ♀ of the former species with the hairs on."

Beetle.—Small, elongate, narrow, shining. Head black, thorax dark ferruginous brown; elytra yellow, bases and apex brown; under-surface brown, legs yellow; antennae yellow, the scape edged with a conspicuous fringe or brush of yellow-brown hairs forming a prominent bunch on either side of the front of head. Head concave in front, with coarse punctures and two deep impressions on either side of a median line extending half-way to vertex; two tufts of yellow hair just above the epistoma turn slightly upwards, four other tufts arising close behind. Prothorax oblong, deeply indented at sides, with a slight median line from base to centre, basal half punctate, rest smooth. Elytra finely striate-punctate, the apices separately rounded. Length, 3.2 mm. to 3.5 mm.

Description.

FIG. 400.
Diapus capillatus, Sampson, sp.n. Darjeeling.

Life History.

In July 1901 Mr. C. G. Rogers obtained a few of these beetles from the wood of a railway sleeper of *Quercus lamellosa* cut in the Darjeeling forests. The insect evidently oviposits in the timber of this tree, but nothing further is at present known about its life history.

UNDETERMINED PLATYPID.

I have been unable to obtain the determination of the following species.

Platypus ? sp.

Habitat.—Lower Burma.

Tree Attacked.—Pyinkadu (*Xylia dolabriformis*). Tharrawaddy, Salween River, Tenasserim.

Beetle.—Black, pointed posteriorly.

Life History.

The beetle tunnels directly down into the wood of the tree, the tunnel curving a little after it has entered the sapwood. The eggs are laid at the bottom of the tunnel, which is several inches in length. I took a dead mother-beetle in the egg-tunnel in a large girdled tree in Tharrawaddy in January 1905, and others mature and just issuing (the first beetles of the year) in trees at Kamamaung, on the Salween River, in Tenasserim, the first fortnight in the following March. The beetle only oviposits in fresh sappy timber.

Hectarthrum heros, Fabr. (pp. 116 and 166).—This beetle is predaceous upon the platypid found in the pyinkadu-tree. It was taken in some numbers in the mature state on 8 March 1908 in company with the *Platypus*.

APPENDIX.

The following insect should be included in the Tenebrionidae (p. 232).

PALORUS.

Palorus minor, Waterhouse.

REFERENCE.—Waterhouse, *Ann. Mag. Nat. Hist.* (6) xiv, 71 (1894).

Habitat.—Calcutta.

Tree Attacked.—Siris (*Albizzia lebbek*). Royal Botanic Gardens, Calcutta.

Description.

Beetle.—Elongate, cylindrical. Dark red-brown, tibiae and tarsi yellowish red. Head smooth, flat, finely rugose, with an elevate longitudinal ridge just above the mouth. Prothorax longer than broad, apex rounded, the apical third with strong transverse asperations changing to transverse striae on disk medianly ; surface punctate and smooth on posterior half. Elytra not one and a half times as long as prothorax ; striate-punctate, the punctures shallow and rather large on disk, smaller laterally ; declivity abrupt, strongly set with asperations and pointed tubercles and sparse spiny setae. Length, about 2 mm. (Description (*mihi*) from a poor specimen.)

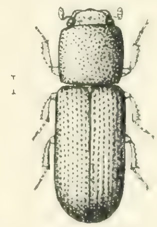


FIG. 401.—*Palorus minor*, Waterhouse, in *Albizzia lebbek*. Calcutta.

Life History.

I cut out a single dead individual of this tenebrionid from a gallery in the wood of a dead siris-tree in the Botanic Gardens in Calcutta towards the end of April 1903. I know nothing further about the insect.

Xyleborus noxius, Sampson, sp. nov.

Described on pp. 598–600.

This insect appears to be also one of the Andamans padauk (*Pterocarpus dalbergioides*) boring beetles. It has been found tunnelling into the wood in a manner similar to that described under *Xyleborus adumbratus* (p. 601) and *X. laeviusculus* (p. 602).

Xyleborus nilgirensis, Hagedorn.

Habitat.—Andaman Islands.

Tree Attacked.—Padauk (*Pterocarpus dalbergioides*). Andamans.

It has quite recently come to my knowledge that specimens of a *Xyleborus* identified as Hagedorn's *nilgirensis* have been taken from padauk wood in the Andamans. The insects were reported as tunnelling down into the hard timber.

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